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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No.

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Additional inventors are being named on the 2nd *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

PLANT NUTRIENT REDUCTION SYSTEM

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ENCLOSED APPLICATION PARTS ***(check all that apply)***

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☐ Application Data Sheet. See 37 CFR 1.76

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METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.

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Respectfully submitted,

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Date 10 February 2004

REGISTRATION NO. 38,330
(if appropriate)
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PROVISIONAL APPLICATION COVER SHEET
Additional Page

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Docket Number	48834.00002

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[Page 2 of 2]

Number 2 of 2

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	Unassigned
Applicant	Paul C. PORTER et al.
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Docket No. 49403-00002
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PATENT OFFICE FEE TRANSMITTAL LETTER

Mail Stop Patent Application
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Sir:

The Commissioner is authorized to charge the following fee to Applicant's deposit account in connection with the filing of the attached papers:

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PLANT NUTRIENT REDUCTION SYSTEM

FIELD OF THE INVENTION

This present invention relates to a plant nutrient reduction system using microbially enhanced inorganic fertilizer compositions.

BACKGROUND OF THE INVENTION

The continuous use of chemical pesticides on plants, bushes and trees and especially those producing crops, has created an imbalance of the microbial eco-system in the soil under them. This results in the need for larger quantities of the chemical pesticides to maintain the same level of crop production, as well as an increased need for fertilizers.

One method used to try to overcome this problem is to use organic fertilizers, such as activated sludge, municipal compost, animal manures such as cow manure, and the like that provide beneficial microbes to improve crop productivity. However, a major drawback of many if not all of these organic fertilizers is the presence in them of toxic chemicals and/or toxic metals that then accumulate in the soil.

Plants grow in complex environments that contain numerous microorganisms. Soil microorganisms in particular exert effects on plants ranging from harmful effects caused by plant pathogens to beneficial effects caused by many soil microorganisms. The presence of a complex soil microbial community is widely recognized as one indicator of soil quality, which in turn results in optimized plant growth.

Several approaches to restoring soil health and maximizing plant growth have historically been used in agriculture. These approaches include amending soil with organic materials, using crop rotations, and using cover crops in between growing seasons. We now understand that these approaches improve soil quality and plant growth because they result in enhanced populations and physiological activity of soil microbes. The problem from the perspective of modern agriculture is that amending soils with large amounts of organic material and often using crop rotations and cover crops is not economically feasible, especially in high production regions such as Florida.

A practical and economically feasible alternative approach to increasing soil microbial populations is the treatment of plants and soils with cultured microbial communities. Adding selected microorganisms, principally bacteria, from among the naturally occurring soil microbial community improves soil quality and results in increased plant growth. Recently, it has been demonstrated that plants treated with beneficial bacteria particularly exhibit increased root growth.

Enhanced root growth via treatment with beneficial microorganisms leads to a more extensive root system with a larger surface area and an increased numbers of root hairs. Root surface area and numbers of root hairs relate directly to a plant's capacity to take up nutrients from soils.

Hence, plants treated with beneficial microorganisms typically exhibit enhanced "nutrient utilization efficiency". This means that at a given level of soil fertility, plants treated with microorganisms take up more nutrients from soil and have higher levels of key nutrients in plant tissues.

The demonstration that microbial inoculants can increase nutrient utilization efficiency has led to an examination of such inoculants for the potential to maintain plant production with the use of reduced levels of fertilizers. Applied fertilizers could be reduced by 25% when beneficial microorganisms are applied to plants and the quality of plant growth and yields can be maintained at levels equivalent to those that result with full fertility rates.

SUMMARY OF THE INVENTION

This invention relates generally to a plant nutrient reduction system using microbially enhanced inorganic fertilizer compositions. More particularly, the present invention relates to a plant nutrient reduction system comprising the application to plants of a microbially enhanced inorganic fertilizer composition wherein said application results in plant growth and yield comparable to the application of substantially greater amounts of a non-microbially enhanced fertilizer composition.

BRIEF DESCRIPTION OF FIGURES

Figure 1. Growth promotion during preparation of tomato transplants. Right shows plant treated with a microbially enhanced inorganic fertilizer composition. Left shows plants treated with weekly fertigation using Peter's Light 20:10:20 with minor elements. A (top) is at 3 weeks after seeding. B (bottom) is at 5 weeks after seeding. At both sample times

treatment with a microbially enhanced inorganic fertilizer composition resulted in significant increases in root and shoot weight at 95% probability level.

Figure 2. Growth promotion of sunflower roots with a microbially enhanced inorganic fertilizer composition. Right was treated with a microbially enhanced inorganic fertilizer composition. Left (control) was treated with weekly fertigation using Peter's Light 20:10:20 with minor elements.

Figure 3. Washed roots from plants in Figure 4. Right = control; left = a microbially enhanced inorganic fertilizer composition. The increase in root weight was significant at the 95% probability level.

Figure 4. Enhanced plant growth of marigold with a microbially enhanced inorganic fertilizer composition (right) compared to control (left). Control plants received weekly fertigation using Peter's Light 20 with minor elements. Enhanced root mass was significant at the 95% level of probability.

Figure 5. Growth promotion of untreated transplants. Tomato plants were grown in transplant trays for four weeks, during which time, all received standard starter fertilizer (Peter's plant starter 9:45:15 at 3 weeks after planting). Plants were transplanted to 4" pots shown here. Plants on right were treated with a microbially enhanced inorganic fertilizer composition. Control plants on left received weekly fertigation using Peter's Light 20:10:20 with minor elements. Photo was taken 3 weeks after transplanting.

Figure 6. Visual appearance cucumber leaves (from experiment shown in Tables 3 and 4). Right shows an older leaf from a plant treated one time with a microbially enhanced inorganic fertilizer composition; left shows a corresponding leaf on plant treated two times with Miracle Gro at the label rate.

DETAILED DESCRIPTION OF THE INVENTION

It is to be understood that this invention is not limited to the particular methodology, protocols, and reagents, etc. described herein and as such may vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention, which will be limited only by the appended claims.

As used herein and in the appended claims, the singular forms "a," "an," and "the" include plural reference unless the context clearly indicates otherwise. Thus, for example,

reference to a microorganism is a reference to one or more such microorganisms and includes equivalents thereof known to those skilled in the art, and so forth.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices, and materials similar or equivalent to those described herein can be used in the practice or testing of the invention, the preferred methods, devices and materials are now described.

All publications and patents mentioned herein are incorporated herein by reference for the purpose of describing and disclosing, for example, the methodologies that are described in the publications, which might be used in connection with the presently described invention. The publications discussed herein are provided solely for their disclosure prior to the filing date of the present application. Nothing herein is to be construed as an admission that the inventors are not entitled to antedate such disclosure by virtue of prior invention or for any other reason.

Other than in the operating examples, or where otherwise indicated, all numbers expressing quantities of ingredients or reaction conditions used herein are to be understood as modified in all instances by the term "about."

The present invention provides a plant nutrient reduction system comprising the application to plants of a microbially enhanced inorganic fertilizer composition wherein said application results in plant growth and yield comparable to the application of substantially greater amounts of a non-microbially enhanced fertilizer composition.

In one embodiment, the plant nutrient reduction system comprises:

A) an inorganic fertilizer, and

B) an effective quantity of beneficial microorganisms that a) enhance plant growth and, where applicable, crop production, and/or b) control various types of pathogens in the soil, optionally in combination with nutrients selected to maintain the viability of the microorganisms and/or increase their population. Such nutrients are well known to those skilled in microbiology.

It is to be understood that use of the term "plant" in the specification and in the claims is meant to include both crop producing and non-crop producing plants, bushes, and trees.

By way of example, the fertilizers (Component A) of the present composition may be a conventional balanced inorganic fertilizer e.g. having an N:P:K ratio of 6:10:4; 7:5:5; 9:13:7; 18:6:12; 19:8:10; 20:3:3; 25:4:4; 28:4:4; 32:10:10, and the like. These numbers show

the percentage of total nitrogen, available phosphorous pentoxide (P_2O_5), and soluble potash (K_2O). This invention is of course not limited by the ratio of nitrogen to phosphorous to potassium in the inorganic fertilizer. The particular inorganic fertilizer selected will depend on the requirements of the soil to be fertilized.

Nitrogen can be present in the inorganic fertilizer in any convenient form, such anhydrous ammonia, aqueous ammonia, ammonium salts such as ammonium nitrate, calcium ammonium nitrate, ammonium phosphate, ammonium sulfate, and ammonium sulfate nitrate, sodium nitrate, potassium nitrate, urea, urea- formaldehyde reaction product, and the like.

Phosphorous can be present in any convenient water soluble form, such as $CaHPO_4$, $Ca(H_2PO_4)_2$, single superphosphate (made by reacting ground phosphate rock with 70% sulfuric acid), ammonium phosphate, nitrophosphates, monorthophosphates such as liquid ammonium polyphosphate, and the like.

Potassium can be present as commercial potash, potassium chloride, carnallite ($KCl. MgCl_2. 6H2O$), potassium sulfate, potassium nitrate, and the like.

Dry blended urea, diammonium phosphate, and potash is a common balanced inorganic fertilizer. While urea and possibly other nitrogen sources may be considered to be organic compounds, fertilizers containing them are predominantly inorganic and are commonly referred to as inorganic fertilizers.

In addition to the primary nutrients, i.e. nitrogen, phosphorous and potassium, secondary nutrients can be present as needed, such as calcium, magnesium, and sulfur. Also, micronutrient elements can also be added if desired such as boron, manganese, zinc, copper, iron, and molybdenum.

While balanced inorganic fertilizers are most commonly used, inorganic fertilizers deficient in one or more of nitrogen, phosphorous and potassium can be used in the practice of the invention , as soil conditions may dictate, e.g. having an N:P:K ratio of 6:2:0; 0:10:0 (bone meal); 16:20:0 (ammonium phosphate); and the like.

Component B) can be any beneficial microbial organism or combination of organisms known to enhance the quality of soil for the growth of plants. Such micororganisms include those from the genera Bacillus, Clostridium, such as *Clostridium pasteurianum,* Rhodopseudomonas, such as *Rhodopseudomonas capsula,* and Rhizobium that fix atmospheric nitrogen; phosphorous stabilizing Bacillus organisms such as *Bacillus megaterium;* cytokinin producing microorganisms such as *Azotobacter vinelandii;* and microorganisms from the genera Pseudomonas, such as *Pseudomonas fluorescens,*

Athrobacter, such as *Anthrobacter globii,* Flavobacterium such as Flavobacteriium sp., Saccharomyces, such as Saccharomyces cerevisiae, *and the like.*

Microorganisms useful in the practice of the invention can be selected from one or more of bacteria, fungi, and viruses that have utility in soil enhancement. Viruses such as the NPV viruses (nuclear polyhedrosis virus) such as the cabbage looper nuclear polyhedrosis virus are examples of useful viruses.

Microorganisms, (bacteria, fungi and viruses) that control various types of pathogens in the soil include microorganisms that control soil-born fungal pathogens, such as Trichoderma sp., *Bacillus subtilis,* Penicillium sp,; microorganisms that control insects, such as Bacillus sp. e.g. *Bacillus popalliae;* microorganisms that act as herbicides, e.g. Alternaria sp., and the like.

All of the above microorganisms are well known and are readily available from public depositories including ATCC and NRRL.

Optional components that can also be present in the fertilizer compositions of the invention include natural enzymes, growth hormones such as the gibberellins (gibberellic acid and gibberellin plant growth hormones), and control agents including Pesticides such as acaracides and molluskicides, insecticides, fungicides, nematocides, and the like, depending of course on their compatibility with the component B) microorganisms. Compounds useful as control agents may have one activity only, but frequently are effective in more than one of the above categories. Examples of control agents that can be used in the compositions of the invention, depending on component B) compatibility, include inorganic compounds such as elementary sulfur and inorganic sulfur compounds, e.g. calcium polysulfide and sodium thiosulfate, which are effective fungicides, copper, zinc, and other metal in organics such as copper carbonate copper oxychloride, copper sulfate, and copper zinc sulfate. Organometallic compounds such as iron and tin compounds, e.g. triphenyl tin hydroxide exhibit both insecticidal and pesticidal activity. Saturated higher alkyl alcohols, either straight or branched chain, such as nonyl and decyl alcohol, can be present as insecticides. Aldehydes such as metaldehyde are an effective molluskicide, e.g. useful against snails. Carbonic acid derivatives, especially their mixed esters, are potent acaracides and fungicides, and when sulfur is also present, e.g. mixed esters of thio- and di-thiocarbonic acids, activity is further increased. 6-methylquinoxaline-2,3-dithiocyclocarbonate is an effective acaricide, fungicide, and insecticide. Carbamic acid derivatives such as aryl esters of N-methylcarbamnic acid, e.g. 1-naphthyl-N-methylcarbamate can also be used. Halogen substituted aliphatic monobasic

and dibasic carboxylic acids are effective pesticides. Natural pyrethrins and their synthetic analogs are also effective pesticides. Salicylanilide is effective against leaf mold and tomato brown spot. Hetercyclic compounds possessing insecticidal and/or fungicidal activity can also be used. Halogen derivatives of benzene, such as paradichlorobenzene, are effective pesticides, often used against the sugarbeet weevil. Chitin-containing products are effective menatocides. Other compounds that can be used include aliphatic mercaptans having four or fewer carbon atoms, organic sulfides and thioacetals, nitro compounds such as chloropicrin dichloronitroethane, and chloronitropropane, copper and zinc inorganic and organic compounds, e.g. copper linoleate, copper naphthenate, etc., organophosphorous compounds of which there are well over a hundred, e.g. DDVP, tris-(2,4-diphenoxyethyl) phosphite, derivatives of mono- and dithiophosphoric acids, such as 0,0-diethyl S [2-ethylthio)-ethyl]phosphorodithioate, phosphoric acid derivatives, pyrophosphoric acid derivatives and phosphonic acid derivatives, quinones, sulfonic acid derivatives, thiocyanates and isocyanates, phytoalexins, insect killing soaps such as potassium fatty acid salts, and antiallatotropins such as 7-methoxy-2,2-dimethylchromene and the 6,7-dimethoxy analog. Diatomaceous earth can be used, which kills crawling insects.

These optional components can comprise from 0.001 to 10% or more by weight of the fertilizer composition. Also, alkalizing agents such as ground limestone and acidifying agents such as inorganic acids or acid salts can be added as needed or desired.

The fertilizer compositions of the invention can be in solid form or in the form of an aqueous solution. Solid forms include powders and larger particulate forms, e.g. from 20 to 200 mesh.

Where the fertilizer compositions are in solid form and component B) microorganisms are sensitive to light, air, or compounds in fertilizer component A) or to optional added components, the microorganisms can be separately encapsulated in water soluble coatings, e.g., dyed or undyed gelatin spheres or capsules, or by micro-encapsulation to a free flowing powder using one or more of gelatin, polyvinyl alcohol, ethylcellulose, cellulose acetate phthalate, or styrene maleic anhydride. The separately encapsulated microorganisms can then be mixed with the powder or larger particulates of component A) (which is not encapsulated) and any optional components. Encapsulation of the microorganisms preferably includes nutrients as well as the microorganisms.

The presence of the component B) microorganisms in the fertilizer compositions of the invention provides further enhancement of plant growth, and where applicable, crop

production, i.e. by further enhancement is meant benefits in plant growth and crop production in addition to the benefits provided by the fertilizer component A), and/or provides control of pathogens in the soil. The fertilizer compositions of the invention can be added to soil to replenish chemical elements that have been reduced or exhausted by the soils from crops previously grown, or which have been leached from the soils as a result of poor tillage practices, overirrigation, or natural flooding, and to add nutrients to soils naturally deficient in them. The selection of the component A) inorganic fertilizer can be customized to the nutrient content of the soil to obtain particular growing objectives.

In one embodiment, the fertilizer composition comprises urea, ammonium phosphate, and potassium5 chloride in a ratio of N:P:K of 25:4:4 with a particle size of 100 mesh and may be intimately mixed with 1 million-500 million *clostridium pasteurianum,* per gram of the composition and 1 million-500 million *Rhodopseudomonas capsula* per gram of the composition.

In another embodiment, the fertilizer composition comprises ammonium sulfate, triple superphosphate, and carnallite in a ratio of 32:10:10 with a particle size of 50 mesh and may be intimately mixed with 1 million-100 million *Bacillus megaterium* or *Bacillus subtilis* in the form of gelatin microcapsules of about 1000 micron diameter, per gram of the composition.

In an alternative embodiment, a liquid fertilizer composition may be formulated comprising KNO_3, $Ca(H_2PO_4)_2$, and KCl in a ratio of N:P:K: of 18:6:12 in water in a concentration of 10% solids. About one million-100 million *Athrobacter globii* per gram of solids may be added to this aqueous solution.

Other embodiments of the present invention include:

1. Advanced All-Purpose Plant Nutrition System 15-8-10

This composition increases overall plant growth by establishing a thicker root system. This energized root system develops more root hairs, grows and supports a larger number of branches, and produces more blooms per plant. The end results are heartier plants and more abundant flowers and vegetables that are more drought resistant and are better able to survive stressful conditions. The composition may be in granular or water-soluble form.

The 15-8-10, N-P-K formulation with micronutrients represents a 45% decrease in chemicals compared with the leading plant food brands which are generally 15-30-15 or 20-20-20. This composition, with 45% less chemicals, reduces the impact on the environment.

Because less chemicals are put into the soil with this composition--yet more is absorbed by the plant--there is, logically, less available as runoff.

2. Premium Potting Soil

Natural growth enhancers speed up the germination process for plants, resulting in a decreased in the time between planting and transplanting. Enables plants to survive transplant better and avoid shock because they carry their own soil friends and family with them in the transplanting process. The establishment of thicker root systems allows the plant to grow and support a larger number of branches, making fuller plants, and the blooms per plant are increased with the microbially enhanced inorganic fertilizer composition.

3. Advanced Lawn Nutrition System 20-0-10

Natural growth enhancers produce thicker, heartier lawns, shrubs and trees that require less watering and contain less chemicals than competing brands. This unique product allows users to apply 75% of the nitrogen per square foot as you would with traditional fertilizer and zero phosphorus, thus reducing chemical pollution in surface waters, groundwater, and into the atmosphere. The use of zero phosphorus is a tremendous shift from traditional lawn fertilizers, and is being mandated by states such as Michigan. This microbially enhanced inorganic fertilizer composition is used for residential lawns, turf, and a solid conditioner for trees and shrubs. The microbially enhanced inorganic fertilizer composition is used by professional golf courses and lawn services.

EXAMPLES

Without further elaboration, it is believed that one skilled in the art, using the preceding description, can utilize the present invention to the fullest extent. The following examples are illustrative only, and not limiting of the remainder of the disclosure in any way whatsoever.

Example 1

Appendix I. (*Evaluating the effect of cane molasses applied alone and in combination with other crop inputs on soybean development and yield*) demonstrates the following. Adding molasses to soil, which is known to stimulate soil microbial populations and physiological activity, increased yield of soybean by 8.7% compared to the non-fertilized control. Note that N-fertilizer is not routinely used on soybean because the N-fixing bacterium *Bradyrhizobium japonicum* forms root nodules and provides the plant with needed nitrogen. When the

microorganisms in a microbially enhanced inorganic fertilizer composition were added along with molasses, yield was increased by 23.3% over the yield of the non-fertilized control and by 13.4% over the treatment with molasses alone.

Example 2

Stimulation of cotton yields by the microorganisms in a microbially enhanced inorganic fertilizer composition is demonstrated in Appendix II. (*Jordan*), which is a report from the University of Georgia. Note on page one that results are summarized from three field trials. Compared to the control, addition of the microorganisms in a microbially enhanced inorganic fertilizer composition increased the pounds of lint 10%, 47%, and 116% in the three trials.

Example 3

Appendix III. (*The effect of a microbially enhanced inorganic fertilizer composition on potato growth and yield in northern Maine—2002*) reports on the evaluation of three application rates of a microbially enhanced inorganic fertilizer composition on potato yield with recommended fertility levels. Compared to the control, thc three rates of a microbially enhanced inorganic fertilizer composition resulted in increases in marketable yicld of 23.5% (treatment 1), 50.5% (treatment 2) and 17% (treatment 3).

Example 4

Appendix IV. (*Evaluating the effect of a microbially enhanced inorganic fertilizer composition on soybean development and yield*) presents results from a trial in 2001 when different mixtures of bacteria that are now in a microbially enhanced inorganic fertilizer composition were being selected. The data show that using in-furrow application of various combinations of microorganisms from a microbially enhanced inorganic fertilizer composition resulted in yield increases, compared to the control, ranging from 17.1% for treatment 5 to 30.3% for treatment 3. Note that the capacity of microorganisms in a microbially enhanced inorganic fertilizer composition to enhance yield of soybean was independent of inoculation with rhizobia. (The designation "WI—with inoculant" refers to the use of rhizobial inoculant). Hence, a microbially enhanced inorganic fertilizer composition is compatible with rhizobia.

Collectively, the testing of a microbially enhanced inorganic fertilizer composition under greenhouse and field conditions on several crops indicates that the selected microorganisms increase plant growth and yield. Given the relationship between healthy roots and fertilizer uptake, it was reasoned that the bacteria in a microbially enhanced

inorganic fertilizer composition, because of their capacity to increase root growth, could be useful in strategies to allow reduced rates of fertilizer. Testing this idea required the development of a microbially enhanced inorganic fertilizer composition.

Tests at Auburn first demonstrated that the new product form still increased plant growth and led to enhanced nutrient content in leaves compared to a standard soluble inorganic fertilizer without bacteria. Cucumber and tomato plants were grown in transplant trays without fertilizer for two weeks (cucumber) or three weeks (tomato). At the time of transplanting to 10-inch round pots, Miracle Gro (20:20:20) was applied at 1 T/gal. A microbially enhanced inorganic fertilizer composition was applied at 1 teaspoon per pot sprinkled over the top. Miracle Gro was reapplied at 10 days after transplanting. A microbially enhanced inorganic fertilizer composition was not applied a second time.

Significant increases in overall plant growth and weight of roots was noted with the a microbially enhanced inorganic fertilizer composition product, although it contained less N and P than Miracle Gro. Leaves from plants were removed at 21 days after transplanting. The same age of leaves were sampled from all plants. There were six replications per treatment. The results shown in Tables 1 and 2 show that the microbially enhanced inorganic fertilizer composition increased tissue concentrations of N and P. Such increases coupled with the reduced input rate of N and P in the microbially enhanced inorganic fertilizer composition product would be expected to result in less residual N and P in the soil. These increases also demonstrate that in the presence of the correct microbial inoculant, the input rates of fertilizer can be decreased.

Table 1. Plant Tissue Analysis of Cucumber Fertilized by a Microbially Enhanced Inorganic Fertilizer Composition vs. Miracle Gro

Treatment	% Potassium	% Phosphate	ppm Iron	% N
A microbially enhanced inorganic fertilizer composition	2.86a	0.48a	683a	2.79a
Miracle Gro	2.58a	0.35b	507b	1.32b
$LSD_{0.05}$	0.66	0.05	114	0.32

Means within a column followed by different letters are significantly different.

Table 2. Plant Tissue Analysis of Tomato Fertilized by a microbially enhanced inorganic fertilizer composition vs. Miracle Gro

Treatment	% Potassium	% Phosphate	ppm Iron	% N
A microbially enhanced inorganic fertilizer composition	2.32a	0.49a	297a	1.71a
Miracle Gro	2.12a	0.42b	154b	0.79b
$LSD_{0.05}$	0.47	0.06	37	0.21

Means within a column followed by different letters are significantly different.

In a follow-up study, reduced rates of a microbially enhanced inorganic fertilizer composition were applied to cucumber and tomato to test the idea that fertility rates could be lowered with no adverse effects on plant growth if the microbially enhanced inorganic fertilizer composition microbial community was applied. In this test, cucumber seedlings were grown 2 weeks without any applied fertilizer (standard practice for transplant production). Then, cucumber plugs were transplanted into 10-inch round pots. Plants were treated with Miracle Gro at the label rate of 1 tablespoon per gallon at the time of transplanting and again 10 days later. The microbially enhanced inorganic fertilizer composition product was applied at ¼ and ½ teaspoons per pot by sprinkling the granular product (fertilizer plus microorganisms) over the top of the planting mix at the time of transplanting without further applications. As shown in Table 3, a single application of a microbially enhanced inorganic fertilizer composition at both low rates promoted cucumber plant growth compared to Miracle Gro applied two times. Results were similar with tomato.

Table 3. Reduced fertilizer rates in the presence of microorganisms with a microbially enhanced inorganic fertilizer composition Bionutritional Formula (A microbially enhanced inorganic fertilizer composition) on cucumber 3 weeks after transplanting.

Treatment	**Application Rate**	**Runner Length (inches)**	**No. of Blooms**	**Leaf width (cm)**
A microbially enhanced inorganic fertilizer composition	¼ tsp at transplanting	40**	3.7*	19.0
A microbially enhanced inorganic fertilizer composition	½ tsp at transplanting	41**	4.0+	21.3+
Miracle Gro 15:30:15	Water w/ 1T/g gal at transplanting and 10 days later	33	0.7	15.9
$LSD_{0.05}$		7.0	3.6	4.8
$LSD_{0.10}$		5.7	2.9	3.9

**Indicates significant difference from treatment 3 at $P = 0.05$.

+ Indicates significant difference from treatment 3 at $P = 0.10$.

As shown in the tables below, on both cucumber and tomato, in addition to stimulating plant growth one application of a microbially enhanced inorganic fertilizer composition resulted in significantly higher plant accumulation of phosphorus, iron, and nitrogen compared to two applications of Miracle Gro. There were no differences between the amount of potassium in plants treated with a microbially enhanced inorganic fertilizer composition or Miracle Gro.

Table 4. Plant Tissue Analysis of Cucumber Fertilized by a microbially enhanced inorganic fertilizer composition vs. Miracle Gro

Fertilizer	% Potassium	% Phosphate	ppm Iron	% N
A microbially enhanced inorganic fertilizer composition @ 1 tsp per pot at transplanting	2.86a	0.48a	683	2.79a
Miracle Gro @ 1 T per gal at transplanting and 10 days later	2.58	0.35b	507b	1.32b
$LSD_{0.05}$	0.36	0.05	114	0.32

Means within a column followed by different letters are significantly different.

Table 5. Plant Tissue Analysis of Tomato Fertilized by a microbially enhanced inorganic fertilizer composition vs. Miracle Gro

Fertilizer	% Potassium	% Phosphate	ppm Iron	% N
A microbially enhanced inorganic fertilizer composition @ 1 tsp per pot at transplanting	2.32a	0.49a	297a	1.71a
Miracle Gro @ 1 T per gal at transplanting and 10 days later	2.12a	0.42b	154b	0.79b
$LSD_{0.05}$	0.47	0.06	37	0.21

Means within a column followed by different letters are significantly different.

Data from several field and greenhouse trials by other universities and private agricultural testing services also indicate that plant quality and nutrient status can be maintained when fertilizer rates are reduced if the microbial community present in a microbially enhanced inorganic fertilizer composition is used.

Example 5

Appendix V. (*Comparative evaluation of a microbially enhanced inorganic fertilizer composition products on turfgrasses*) presents results of comprehensive greenhouse and field trials conducted by Professor J.B. Sartain at the University of Florida using a microbially enhanced inorganic fertilizer composition at 100%, 75%, and 50% of the recommended N-

fertility level for turf in Florida. Several of Prof. Sartain's findings (cited here by the corresponding Figure shown within the Appendix) demonstrate that a microbially enhanced inorganic fertilizer composition is useful as a strategy to maintain plant production while decreasing fertilization rates:

- Treatment of St. Augustine grass with a microbially enhanced inorganic fertilizer composition at 75% N resulted in a visual quality rating (indicating overall turf quality and density) of 6.21 which is greater than the minimum acceptable rating of 5.5 for St. Augustine grass (Figure 5).

- Treatment of St. Augustine grass with a microbially enhanced inorganic fertilizer composition at 75% N resulted in root weights that were statistically equivalent to treatment with Turfbuilder, Lesco, and Pursell, all at 100% N (Figure 7).

- Use of a microbially enhanced inorganic fertilizer composition at 75% N resulted in total dry matter accumulation on St. Augustine grass that was statistically equivalent to 100% N fertilization with Turfbuilder, Lesco, and Pursell (Figure 8).

- The mean visual quality throughout the test (Figure 12) was not significantly different between a microbially enhanced inorganic fertilizer composition at 75% N and Turfbuilder at 100% N, although it was reduced compared to the 100% N rate of the other two products.

- On Bermuda grass, mean quality with a microbially enhanced inorganic fertilizer composition at 75% N was statistically equivalent to 100% N (Figure 16).

- A key finding which supports the premise that applied microorganisms coupled with a 25% reduction in fertilizer use can result in less fertilizer leaching is in Figure 17. Treatment of Bermuda grass with a microbially enhanced inorganic fertilizer composition Bio- Nutrition at 75% N resulted in a 73% reduction in total leached N compared to the 100% N level.

- Figure 22 shows that Bermuda the average root dry weight from treatment with a microbially enhanced inorganic fertilizer composition at 75% N was not significantly different from that at the 100% N level.

- Similarly, total dry matter accumulation and overall quality of Bermuda grass from treatment with a microbially enhanced inorganic fertilizer composition at 75% N was not significantly different from that at the 100% N level (Figures 23 and 27)

- Overall quality of Bermuda grass was also not significantly different with the rate of a microbially enhanced inorganic fertilizer composition at 75% N compared to the 100% N level (Figure 28).

- In a separate investigation to determine how treatments affected "grow in" (the rate at which the ground surface is covered with turf after "sprigging") of St. Augustine grass, a microbially enhanced inorganic fertilizer composition at 75% N was not significantly different from the 100% N level (Figure 26). The reference to W (Wedge) in this study refers to an additional treatment of the microbial component already present in a microbially enhanced inorganic fertilizer composition .

- In the same study, the tissue mass of St. Augustine grass, root weight, mean visual quality, and total N uptake resulting from a microbially enhanced inorganic fertilizer composition at 75% N was not significantly different from the 100% N level (Figures 29, 30, 31, and 31).

- In the case of root dry weight, use of a microbially enhanced inorganic fertilizer composition at 50% was not significantly different from the 100% N level (Figure 30).

- A key finding in this study was that the quantity of N leached was reduced by treatment with a microbially enhanced inorganic fertilizer composition at 75% N by 45% from the 100% N rate with added microbes (W in Figure 33) and by 43% from the 100% N rate without added microbes.

- In a separate study on growth rates of Bermuda grass, both the 75% N and 50% N rates of a microbially enhanced inorganic fertilizer composition resulted in the tissue dry weights as the 100% N rate (Figure 35). Note that in this study, all the treatments received added microorganisms (W in the Figures), which may explain why the 50% N level results were equivalent to the higher N levels.

- Similarly, the total dry mass was not significantly different among the 50%, 75%, and 100% N levels for a microbially enhanced inorganic fertilizer composition (Figure 37).

- Total uptake of N, P, and K were not significantly different among the 50%, 75%, and 100% N levels for a microbially enhanced inorganic fertilizer composition (Figures 38, 39, and 40).

- The total N leached was reduced by 55% from the 100% N rate by treatment with a microbially enhanced inorganic fertilizer composition at 75% N. Treatment with a microbially enhanced inorganic fertilizer composition at 50% N reduced N leached by 86% of the control (Figure 41).

- Total P leached was reduced from the control (100% N) by 45% with the 75% N treatment of a microbially enhanced inorganic fertilizer composition and by 78% with the 50% N rate (Table 42).

Example 6

Appendix VI. (*Evaluating effects of a biological fertilizer (NA2101A) on tomato growth in south Florida)* reports a comparison of 100% recommended N fertilizer without microbes to 75% and 50% recommended N with the a microbially enhanced inorganic fertilizer composition microorganisms. The following key results should be noted.

- Treatment with 75% N plus a microbially enhanced inorganic fertilizer composition microorganisms resulted in yields of extra-large and total marketable fruit that were not significantly different from the 100% N rate (Table 1).

- Measurements of leaf greenness (SPAD readings) were only greater for the 100% N rate very early in the season (14 days after transplanting) (Table 2).

- At 28, 42, and 88 days after transplanting, leaf greenness for plants treated with the 75% N rate plus a microbially enhanced inorganic fertilizer composition microorganisms was not significantly different from the 100% N rate (Table 2).

Example 7

Appendix VII. (*The effect of a microbially enhanced inorganic fertilizer composition microbial amendment on St. Augustine grass quality and growth in south Florida)* investigates the effect of various treatment regimes of a microbially enhanced inorganic fertilizer composition microorganisms (a microbially enhanced inorganic fertilizer composition) at three rates of N-fertilizer. Key findings include the following points.

- Treatment with 75% N plus a microbially enhanced inorganic fertilizer composition (treatment 4) resulted in quality ratings that were not significantly different to those from 100% N without microorganisms (treatment 6) on all 7 tested dates (Table 1).

- Treatment with 50% N plus a microbially enhanced inorganic fertilizer composition (treatment 5) resulted in quality ratings that were not significantly different to those from 100% N without microorganisms (treatment 6) on 5 of the 7 tested dates (Table 1).

- Color ratings resulting from treatment with 75% N plus a microbially enhanced inorganic fertilizer composition were not significantly different from treatment with 100% N without microorganisms at 6 of the 7 tested dates (Table 2).

- Dry weights of clippings resulting from treatment with 75% N plus a microbially enhanced inorganic fertilizer composition were statistically equivalent to those resulting from 100% N without microorganisms on all 4 test dates (Table 3).

- Dry weights from the 50% N plus a microbially enhanced inorganic fertilizer composition treatment were not significantly different from the 100% N without microorganism treatment on 3 of the 4 tested dates (Table 3).

Example 8

Appendix VIII. (*Alternative nitrogen sources for corn*) investigates the effect of a microbially enhanced inorganic fertilizer composition microorganisms on corn with three rates of N applied in two different forms. Key results include the following.

- When nitrogen was supplied as urea, the addition of a microbially enhanced inorganic fertilizer composition's microorganisms, All Purpose Plant Formula (APPBNF) resulted in a yield at 160 lbs/A N of 140.9 bu/A, which was greater than the yield resulting from 200 lbs/A urea without microorganisms (137.4 bu/A) (Table 3).

- Hence, the addition of microorganisms maintained yields with a 20% reduction in N (160 vs 200 lbs N/A).

- Note that N uptake at 160 lbs N/A with microorganisms (3.10%) was not higher from uptake at 200 lbs N/A without microorganisms (3.14%). Hence, the increased yield resulting at the 160 lb N rate with microorganisms compared to the 200 lb N rate without microorganisms is due to more than just N-uptake. This finding is consistent with past reports that the microorganisms in a microbially enhanced inorganic fertilizer composition benefit plants by causing several different effects.

Example 9

Appendix IX. (*Evaluating the effect of a microbially enhanced inorganic fertilizer composition on field corn development and yield at full and half fertilizer rates)* presents results of a study in 2001 aimed at selecting the best mixture of a microbially enhanced inorganic fertilizer composition microorganisms. Treatments of microorganisms were compared at full and half-rates of starter fertilizer with or without side dressing. Key findings include the following.

- Compared to the control of full starter fertilizer rate plus side dressing (treatment 10 on page 9), one mixture of a microbially enhanced inorganic fertilizer composition microorganisms (treatment 2) increased yield by 22%.

- The best microbial mixture combined with half-rate of starter fertilizer (treatment 5) resulted in a yield increase of 15.7% over the rate of the full starter fertilizer control without microorganisms (treatment 10).

These data indicate the potential of inoculated beneficial microorganisms to promote plant growth. This technology also demonstrates that specific beneficial microorganisms can increase root growth with the resulting general effect of increasing nutrient utilization efficiency. The case studies presented show that a microbially enhanced inorganic fertilizer composition can be used to allow reductions in fertilizer input of at least 25%. Specific application regimes, and possibly microbial formulations, may be optimized for different crops and different regions of the country.

Research Studies Supporting Dr. Kloepper's Paper Documenting and Summarizing the Use of Microorganisms as an Effective Nutrient Reduction Strategy

Appendix I.

Evaluating the Effect of Cane Molasses Applied Alone and in Combination with Other Crop Inputs on Soybean Development and Yield

Westway™ Trading Corporation Precision Concept Research Design

Evaluating the Effect of Cane Molasses Applied Alone and in Combination with Other Crop Inputs on Soybean Development and Yield

Project Code: S-06 — Location: Hollandale, MN

Sponsor: Westway Trading Corporation — By: Agri-Growth, Inc.

Site Layout

Length of Field
800 Feet

22'

1 Replicate—132 feet

1. Cane Molasses	**2 qts/A**
+ 3-18-18 Starter Fertilizer	**4 gal/A**
2. Cane Molasses	**2 qts/A**
+ Magnify™ (inoculant)	**100 ml/100 bu of seed**
+ 3-18-18 Starter Fertilizer	**4 gal/A**
3. Cane Molasses	**2 qts/A**
+ AmiSorb® (Nutrient Absorption Enhancer™)	**2 qts/A**
+ 3-18-18 Starter Fertilizer	**4 gal/A**
4. Cane Molasses	**2 qts/A**
+ Soil X-CYTO® (growth regulator)	**10 oz/A**
+ 3-18-18 Starter Fertilizer	**4 gal/A**
5. Cane Molasses	**2 qts/A**
+ Naturize™ Fertility Microbes (biological)	**30 oz/A**
+ Plasma	**30 oz/A**
+ 3-18-18 Starter Fertilizer	**4 gal/A**
6. Control (used as baseline) H_2O only	**5 gal/A**

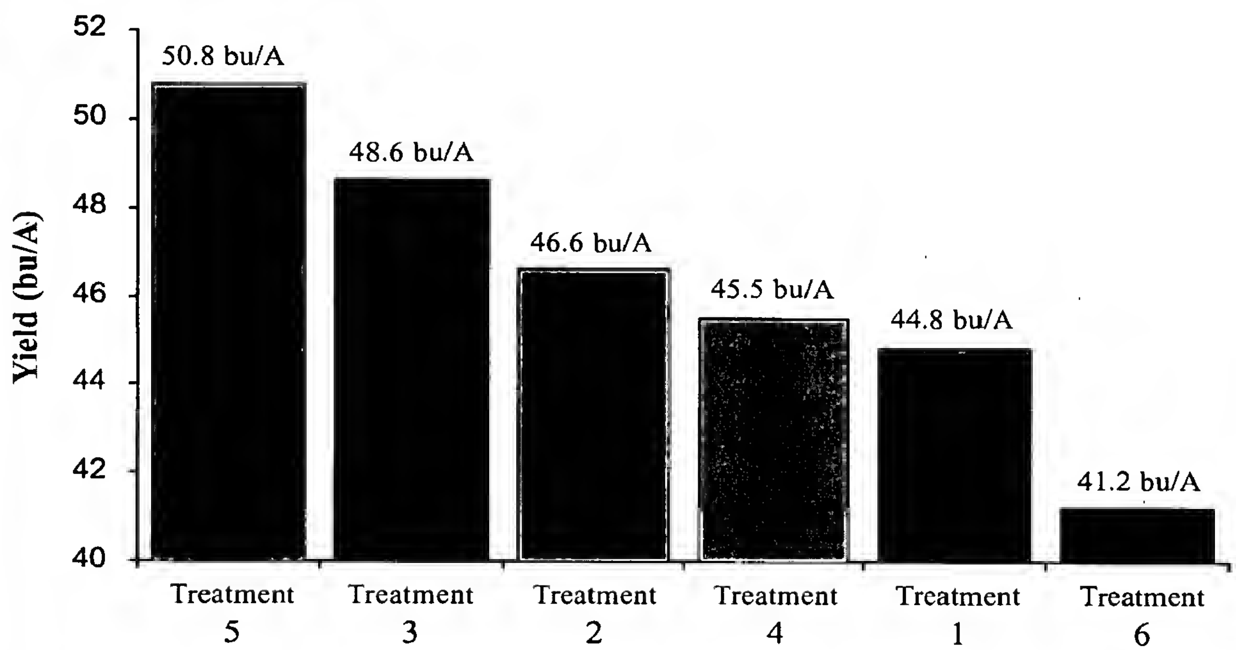
- Each treatment replicated 5 times
- All at-plant treatments applied in-furrow.
- 5 gal/A H_2O on each of the 6 treatments.

Westway™ Trading Corporation Precision Concept Research Design

Evaluating the Effect of Cane Molasses Applied Alone and in Combination with Other Crop Inputs on Soybean Development and Yield

Project Code: S-06 — Location: Hollandale, MN

Sponsor: Westway Trading Corporation — By: Agri-Growth, Inc.



- Each treatment replicated 5 times
- All at-plant treatments applied in-furrow.
- 5 gal/A H_2O on each of the 6 treatments.
- Treatments:
  1. Cane Molasses at 2 qts/A + 3-18-18 Starter Fertilizer at 4 gal/A
  2. Cane Molasses at 2 qts/A + Magnify™ (inoculant) at 100 ml/100 bu of seed + 3-18-18 Starter Fertilizer at 4 gal/A
  3. Cane Molasses at 2 qts/A + AmiSorb® (Nutrient Absorption Enhancer™) at 2 qts/A + 3-18-18 Starter Fertilizer at 4 gal/A
  4. Cane Molasses at 2 qts/A + Soil X-CYTO® (growth regulator) at 10 oz/A + 3-18-18 Starter Fertilizer at 4 gal/A
  5. Cane Molasses at 2 qts/A + Naturize™ Fertility Microbes (biological) at 30 oz/A + Plasma at 30 oz/A + 3-18-18 Starter Fertilizer at 4 gal/A
  6. Control (used as baseline) (H_2O only)

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Westway™ Trading Corporation Precision Concept Research Design

Evaluating the Effect of Cane Molasses Applied Alone and in Combination with Other Crop Inputs on Soybean Development and Yield

Project Code: S-06 | Location: Hollandale, MN

Sponsor: Westway Trading Corporation | By: Agri-Growth, Inc.

Treatments	Rate	Yield bu/A
5. Cane Molasses	2 qts/A	50.8
+ Naturize™ Fertility Microbes (biological)	30 oz/A	
+ Plasma	30 oz/A	
+ 3-18-18 Starter Fertilizer	4 gal/A	
3. Cane Molasses	2 qts/A	48.6
+ AmiSorb® (Nutrient Absorption Enhancer™)	2 qts/A	
+ 3-18-18 Starter Fertilizer	4 gal/A	
2. Cane Molasses	2 qts/A	46.6
+ Magnify™ (inoculant)	100 ml/100 bu of seed	
+ 3-18-18 Starter Fertilizer	4 gal/A	
4. Cane Molasses	2 qts/A	45.5
+ Soil X-CYTO® (growth regulator)	10 oz/A	
+ 3-18-18 Starter Fertilizer	4 gal/A	
1. Cane Molasses	2 qts/A	44.8
+ 3-18-18 Starter Fertilizer	4 gal/A	
6. Control (used as baseline) (H_2O only)	5 gal/A	41.2

Means followed by the same letter do not significantly differ (P = .05 Duncan's MRT)

- Each treatment replicated 5 times
- All at-plant treatments applied in-furrow.
- 5 gal/A H_2O on each of the 6 treatments.
- Treatments:
  1. Cane Molasses at 2 qts/A + 3-18-18 Starter Fertilizer at 4 gal/A
  2. Cane Molasses at 2 qts/A + Magnify™ (inoculant) at 100 ml/100 bu of seed + 3-18-18 Starter Fertilizer at 4 gal/A
  3. Cane Molasses at 2 qts/A + AmiSorb® (Nutrient Absorption Enhancer™) at 2 qts/A + 3-18-18 Starter Fertilizer at 4 gal/A
  4. Cane Molasses at 2 qts/A + Soil X-CYTO® (growth regulator) at 10 oz/A + 3-18-18 Starter Fertilizer at 4 gal/A
  5. Cane Molasses at 2 qts/A + Naturize™ Fertility Microbes (biological) at 30 oz/A + Plasma at 30 oz/A + 3-18-18 Starter Fertilizer at 4 gal/A
  6. Control (used as baseline) (H_2O only)

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Appendix II.

In-Furrow Fungicide Trial (2001) and Cotton Research Trial (2002)

Lanier Jordan put out an Equity trial in Baker County, Georgia with Chad Heard (grower). Three plots were established ranging in size from 1.076 acres (treated) to 1.96 acres (check).

Researcher:	Lanier Jordan
Planting Date:	June 1-5, 2002
Trials:	3 sites
Variety	Fibermax 989
Application Timing	1st app at planting over the row 2nd app at 4th true leaf stage – applied with first Round-Up spray
Rate:	2.5 qts at planting + 2.5 quarts @ 4th true leaf
Irrigation	Fields were irrigated immediately following planting and once each week during the growing season
Soil Insecticide:	Temik @ 3-5 lbs/acre for thrip control (no nematode infestation)
Soil Fungicide:	None
Trial Harvest:	Used boll buggy in all 3 trials

No visual differences were observed during the growing season by either the grower or the extension agent. Initial expectation was that the yields would be similar. However, yield responses on the treated plots demonstrated consistent increases, with one trial more than doubling the control plot yield.

PLOT	ACRES	LBS. SEED COTTON		LBS LINT	ROI[1]
1 Check	1.144	1870		656	
2 Test	1.577	3810		934	
			Increase	310	$192.57
2 Check	1.96	2780		567.35	
2 Test	1.021	2940		1200.346	
			Increase	633.346	$425.38
3 Check	1.1	2560		930.909	
3 Test	1.076	2760		1026.022	
			Increase	95.113	$37.85

1-ROI calculations based on: Equity cost @ $24.50/gallon & cotton at $.72/lb

Lanier was very encouraged with the results and noted that all trials showed increases that were economically important to grower

Project Title:	2001 In-Furrow Fungicide Trial
Project Number:	COT02007
Prin. Investigator:	K.W. Seebold
Cooperator:	Various
Location:	Tifton, GA – Blackshank Farm Field 1243/1244
Test Type:	In-furrow fungicide
Exp. Design:	Randomized complete block
Replications:	5
Plot Size:	25' row length, two row plots (both rows inoculated); 10' borders between blocks.
Row Spacing:	36"
Seeding Rate:	3 seed per row-foot
Cultivar:	DP458 B/RR
Planting Date:	April 29, 2001; Replanted May 13 due to seeding depth problem.
Equipment:	Almaco cone planter In-furrow sprays applied at 5 GPA using a single 80015 nozzle centered over the row (behind row opener and adjusted to cover side walls of furrow). Carbon dioxide (30 psi) was used to power the in-furrow sprayer.
Inoculation:	*Rhizoctonia solani* AG-4 and *Pythium irregulare* were grown on sterile rye for 3 weeks. Oats were dried in a laminar flow hood and then ground to the consistency of coarse sand and blended 1:1 with coarse sand to improve flow. The resulting inoculum was delivered in-furrow at a rate of 1 gram per 10 feet of row using a planter-mounted applicator.
Data:	Stand counts @ 14 and 28 DAP Phytotoxicity at each stand count Plant height/color Yield (seed cotton) Temperature of soil at 2" depth; rainfall until final stand.
Duration:	Experiment terminated on 10/28/02
Management:	Fertility, insects, and weeds were managed according to GA Coop. Extension Service guidelines. Records of actions taken will be kept throughout the season.

Results and Discussion

Inoculation of test plots with *Rhizoctonia solani* created heavy disease pressure despite the late planting date. Plant emergence at 14 days after planting (DAP) and final stand at 28 DAP were significantly increased by in-furrow combinations of Quadris 2.08SC (4 fl oz/A) plus Ridomil Gold 4EC (0.75 fl oz/A) and Quadris 2.08SC (5 fl oz/A) plus Ridomil Gold 4EC (1 fl oz/A), as well as Terraclor Super-X 2.5EC applied at 48 fl oz/A (P=0.05) (Table 1).. Stand uniformity was greatest for Terraclor Super-X, which gave the lowest skip index at 28 DAP. Plant height was lowest, compared to treated seed alone, where T-22 was applied at 1.0 lb/A. No differences in plant height were seen between the remaining treatments and treated seed alone.

No differences in yield of seed cotton (lb/A) were seen between treated seed alone and any of the in-furrow materials applied at planting.

Table 1. Effect of furrow-applied fungicides on stand, emergence, skip indices, and height of cotton in plots inoculated with *Rhizoctonia solani* AG-4.

Trt	Material	Product rate	Application timing	% emergence per 50 ft of row: 14 DAP[a]	28 DAP	Skip index[b]	Plant height (mm)[c]
1	Standard Seed Trt.		Preplant	65.4 bcd	66.1 cd	6.2 bc	183.4 abc
	Baytan 20 318FS	10 g ai / 100 kg seed					
	Thiram 42S 480FS	31 g ai/ 100 kg seed					
	Allegiance-FL 318S	15 g ai/ 100 kg seed					
2	NA2101	2 qt / acre	In-furrow	60.8 d	61.5 d	8.4 ab	189.5 ab
	NA2101	2 qt / acre	Side-dress				
	NA2101	2 qt / acre	1st bloom				
3	NA2101	2 qt / acre	In-furrow	70.2 ab	67.5 cd	4.8 bcd	173.5 cd
	NA2101	1 qt / acre	Side-dress				
	NA2101	1 qt / acre	1st bloom				
4	NA2101	2 qt / acre	In-furrow	64.4 bcd	66.1 cd	6.4 bc	192.1 a
	NA2101	2 qt / acre	1st Bloom				
5	NA2101	4 qt / acre	In-furrow	71.0 ab	71.2 bc	2.6 cd	174.6 cd
6	T-22 1.15WP	1 lb / acre	In-furrow	69.4 abc	71.3 bc	5.4 bcd	165.0 d
7	T-22 1.15WP	2 lb / acre	In-furrow	61.7 cd	61.1 d	10.8 a	176.5 bcd
8	Quadris 2.08SC	4 oz / acre	In-furrow	75.7 a	77.6 ab	3.4 cd	177.6 bcd
	Ridomil Gold 4EC	1 oz / acre					
9	Quadris 2.08SC	5 oz / acre	In-furrow	76.4 a	77.3 ab	4.2 cd	176.9 bcd
	Ridomil Gold 4EC	1 oz / acre					
10	Terraclor Super X 2.5EC	48 oz / acre	In-furrow	75.1 a	80.5 a	1.8 d	173.4 cd
			P-value (ANOVA)	0.0007	0.0001	0.001	0.002

Means followed by the same letter do not differ significantly according to Fisher's protected least significant difference test (P-values for each variable).

[a]DAP=days after planting (cotton planted 5/13/02).

[b] Skip Index: missing stand 12-18 inches in length assigned a value of 1; a score of 1 was added for each 6-inch increase in a given skip. Data taken at 28 days after planting.

[c]Plant heights measured at 28 DAP.

Table 2. Effect of furrow-applied fungicides on yield of cotton in plots inoculated with *Rhizoctonia solani* AG-4.

Trt	**Material**	**Product rate**	**Application timing**	**Seed cotton yield (lbs/A)**
1	Standard Seed Trt.		Preplant	2329 abc
	Baytan 20 318FS	10 g ai / 100 kg seed		
	Thiram 42S 480FS	31 g ai/ 100 kg seed		
	Allegiance-FL 318S	15 g ai/ 100 kg seed		
2	NA2101	2 qt / acre	In-furrow	2033 bc
	NA2101	2 qt / acre	Side-dress	
	NA2101	2 qt / acre	1st bloom	
3	NA2101	2 qt / acre	In-furrow	2799 a
	NA2101	1 qt / acre	Side-dress	
	NA2101	1 qt / acre	1st bloom	
4	NA2101	2 qt / acre	In-furrow	2605 ab
	NA2101	2 qt / acre	1st Bloom	
5	NA2101	4 qt / acre	In-furrow	2376 abc
6	T-22 1.15WP	1 lb / acre	In-furrow	1917 c
7	T-22 1.15WP	2 lb / acre	In-furrow	2567 ab
8	Quadris 2.08SC	4 oz / acre	In-furrow	2288 abc
	Ridomil Gold 4EC	1 oz / acre		
9	Quadris 2.08SC	5 oz / acre	In-furrow	2329 abc
	Ridomil Gold 4EC	1 oz / acre		
10	Terraclor Super X 2.5EC	48 oz / acre	In-furrow	2166 abc
			P-value (ANOVA)	0.005

Means followed by the same letter do not differ significantly according to Fisher's protected least significant difference test (P-values for each variable).

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Dr. K nny Seebold
Cotton Research Trial -2002 -Tifton,GA-Blackshank Farm
Effect of Furrow Applied Fungicides on Stand, Emergence, Skip Indices, Height and Yield of Cotton
Innoculated with *Rhizoctonia solani*

Material	Product Rate	Application Timing	Seed Cotton Yield	Yield Variance	% of Stan Treatment	Lint @ 36%	Yield Variance	% of Stan Treatment	ROI Per Acre
Standard Treatment		Preplant	2329	0	100%	838.44	0	100%	
Baytan 20	10 ga ai/100 kg seed								
Thiram 42S	31 g ai/100 kg seed								
Allegiance FL	15 g ai/100 kg seed								
NA2101	2 qt/acre	In-furrow	2033	-296	87%	731.88	-106.56	87%	[redacted]
NA2101	2 qt/acre	Side-dress							
NA2101	2 qt/acre	1st bloom							
NA2101	2 qt/acre	In-furrow	2799	470	120%	1007.64	169.2	120%	$ 80.40
NA2101	1 qt/acre	Side-dress							
NA2101	1 qt/acre	1st bloom							
NA2101	2 qt/acre	In-furrow	2605	276	112%	937.8	99.36	112%	$ 24.85
NA2101	2 qt/acre	1st bloom							
NA2101	4 qt/acre	In-furrow	2376	47	102%	855.36	16.92	102%	[redacted]
T-22 1.15WP	1 lb/acre	In-furrow	1917	-412	82%	690.12	-148.32	82%	
T-22 1.15WP	2 lb/acre	In-furrow	2567	238	110%	924.12	85.68	110%	
Quadris 2.08SC	4 oz/acre	In-furrow	2288	-41	98%	823.68	-14.76	98%	
Ridomil Gold 4EC	1 oz/acre								
Quadris 2.08SC	5 oz/acre	In-furrow	2329	0	100%	838.44	0	100%	
Ridomil Gold 4EC	1 oz/acre								
Terroclor Super X 2.5EC	48 oz/acre	In-furrow	2166	-163	93%	779.76	-58.68	93%	

Comments

4 treatments showed a yield increase over standard.

The greatest yield increase (120%) was with NA2101. 3 applications, at 2qts; 1qt; 1 qt with $80.40 ROI

The second greatest yield increase was NA2101 (112%), applied twice at 2 qts; 2 qts with $24.85 ROI

T-22 had the third greatest increase (110%) at 2 lb/acre in-furrow greatest increase (110%) at 2 lb/acre

Quadris + Ridomil Gold showed no increase over standard and a slight decrease at the 4 oz Quadris rate

The 4 qt in-furrow NA2101 application showed a 2% increase in yield vs. the standard, however the ROI was a -$14.01

Appendix III.

Initial Evaluation of Several Commercial "Growth Enhancers" in an On-Farm Trial at Fort Fairfield, Maine (2002)

Title: Initial Evaluation of Several Commercial "Growth Enhancers" in an On-Farm Trial Conducted at Fort Fairfield, Mainc in 2002.

Investigator: Peter Sexton, UMCE, Presque Isle Office.

Summary:
Several materials being marketed for the potato crop were evaluated, mostly as in-furrow treatments, in an on-farm trial. The trial was conducted with 'Russet Burbank' potatoes grown at Fort Fairfield, Maine in 2002. The closing disks were raised on the planter so the seed was left uncovered in the trial area. In-furrow applications of different materials were made at rates shown in Table 1 and the furrows were closed by hand. Each plot consisted of four rows 24 fcet long and was bordered by two untreated rows. All treatments were replicated four times in a randomized complete block design. The grower applied 190:230:230 lbs per acre NPK along with 2.5 lb Zn and 0.5 lb B. Leaf tissue sampling was conducted throughout the season and no nutrient deficiencies were observed. Plots treated with gibberellic acid emerged on average 2 days earlier than the other plots in the trial. Visual ranking of the plots in late July and again in early September failed to show any differences between treatments in health and vigor of the shoots. At harvest a single row eighteen feet long was dug out of the center of each plot. Potatoes were baggcd by hand following the digger. Yield samples were graded by size and weighed. Yield data is shown in Table 2. There were no significant differences among the treatments in total yield nor in tubers less than 2.5 inches in size. Plots treated with gibberellic acid had fewer large tubers and tended to have a greater amount of small tubers. The field experienced some drought stress in late August and early September so the yield of tubers larger than 3.25" diamcter was quite variable. The grower estimated that this farm produced about 340 cwt per acre, which is within 10 % of the average yield from the small plots, so it appears the trial was on a representativc sitc. In this experiment, none of the products yieldcd significantly more than the control. The trial should be repeated over several seasons to see how the materials perform under varying conditions.

Table 1. List of materials evaluated for effect on potato yield in an on-farm study conducted at Fort Fairfield, Maine in 2002.

Compound	In Furrow Rate	Foliar Rate
ACA-plus	32 oz/ac	none
Calcium Nitrate	10 lbs/ac	none
control	none	none
Control-2	none	none
Crop Set	8 oz/acre	none
Early Harvest	2 oz. acre	none
GA3	0.25 lb/ac	none
Messenger	none	8.1 oz/ac at 13 and 43 DAE
Naturize 2x	2 qts/ac	2 qt/ac at 13 DAE
Naturize	4 qts/ac	none
ProStart	5 gallons/acre	none
Stimulate	6 oz/ac in furrow	none
Stimulate w/ ACA	6 oz Stimulate plus 32 oz. ACA	none

Table 2. Yield data from an on-farm trial with several commercial "growth enhancers". The trial was conducted at Fort Fairfield, Maine in 2002. Yields are reported in cwt per acre according to the sizes shown on on the table. The trial was set up in a randomized complete block design with 4 replications and two sets of control plots.

Treatment	Hills per ac.	< 1.88"	1.88 to 2.50"	2.50 to 3.25"	> 3.25"	Total Yield	Specific Gravity
		(cwt)	(cwt)	(cwt)	(cwt)	(cwt)	
ACA plus	8493	68	72	208	24	372	1.080
Calcium Nitrate	8244	65	80	203	12	359	1.076
Control	8659	65	83	208	19	375	1.077
Control #2	8969	55	64	211	48	360	1.079
Crop Set	8260	53	59	215	36	364	1.074
Early Harvest	9182	70	88	203	13	373	1.077
GA3	8402	94	112	141	11	358	1.079
Messenger	8770	57	78	212	28	375	1.080
Naturize split	9084	54	59	246	21	381	1.078
Naturize	8266	63	79	182	20	344	1.077
Prostart	9188	76	91	215	11	393	1.077
Stimulate + ACA	8902	68	69	216	2	355	1.076
Stimulate	8953	57	90	206	16	370	1.078
average	8720	65.1	78.7	205.2	19.0	368	1.077
LSD	NS	NS	NS	41.4	20.6	NS	NS
CV (%)	11.5	27	26.7	14.1	74.0	9	0.3

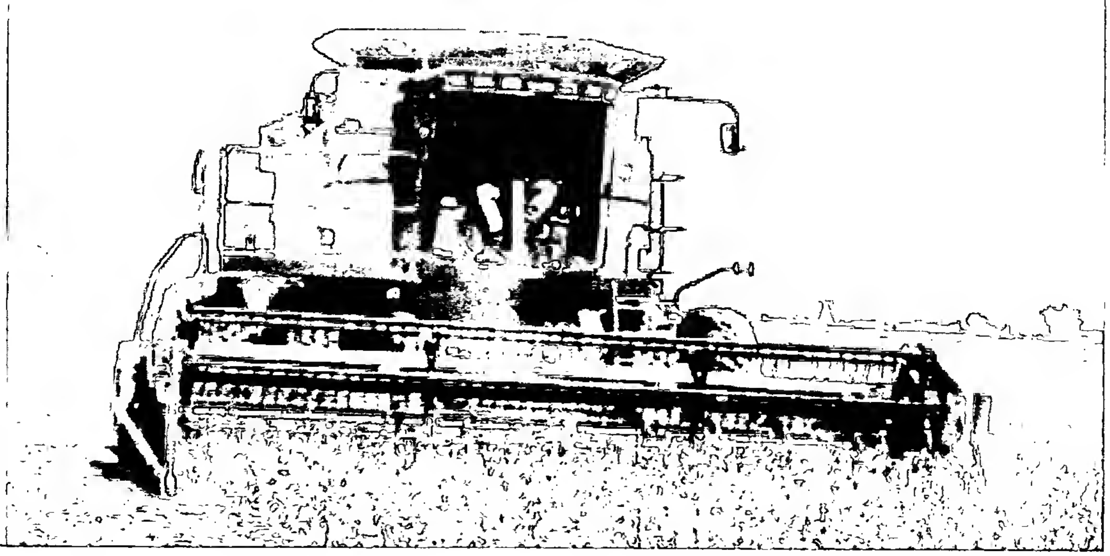
Appendix IV.

Evaluating the Effect of Naturize on Soybean Development and Yield (2001)

NATURIZE™ BIOSCIENCES

2001 PRECISION CONCEPT RESEARCH

Evaluating the Effect of Naturize™ on Soybean Development and Yield



AGRI-GROWTH®
Communicating leading technology to a changing industry

2001 S-02

Introduction

Precision Concept Research is research in actual commercial field situations. It takes up where traditional small plot research leaves off by incorporating field-sized variability of real growing conditions. Today's growers want hard proof that a product, service or management option has been tested under field conditions similar to their own. The strength of precision concept research is that it provides results to growers that are calculated into returns on investment, which pertain to their bottom line.

This booklet records the results of precision concept research undertaken by Agri-Growth, Inc., for AgriEnergy Resources during the 2001-growing season. The research involved a study **(Evaluating the Effect of Naturize™ on Soybean Development and Yield)** that looked at Naturize™ for soybeans.

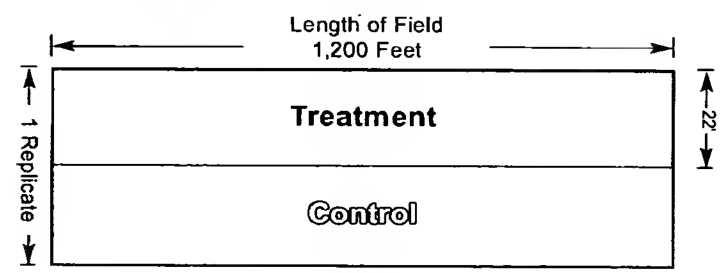
Agri-Growth, Inc.

Agri-Growth® is an independent third party supplier of applied research and education to the food and fiber industry. For 22 years we have been converting information and new technologies into applied knowledge, enabling growers to maximize profits while managing risk. Agri-Growth is a forerunner in precision concept research. Our experts in Geographic Information Systems (GIS) design research studies using precision farming components: Global Positioning System, variable rate applications, geostatistics, aerial imaging and yield monitors.

Precision Concept Research

The main advantage of doing precision concept research is that it allows an evaluation of product performance based on real stress factors in crop growth and development. Traditional small plot or laboratory research data gathered under ideal growing conditions is less relevant to growers who deal with weather, pest, and soil variability on a daily basis. By looking at the performance of inputs or agronomic practices and services within natural cropping situations, evaluations can be based on the product's ability to compensate for stress factors to improve crop growth and development.

Protocols Agri-Growth has developed for conducting research require the use of field-sized plots ranging from 15 to 80 acres in size and the use of a combine with GPS and a yield monitor. In designing research studies, Agri-Growth alternates treatment and check strips that match planter and combine width. This protocol is easily adapted for testing many different products, rates, planting populations, and tillage practices. The more strips that are placed in the field the better the study will be.

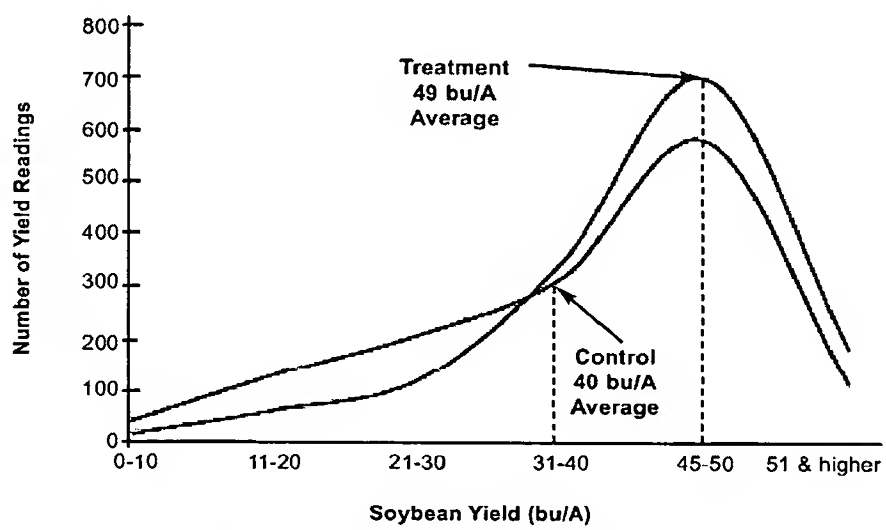


Strip layout.

At harvest each treatment strip is entered as a different load in the yield monitor. Like other precision instruments, yield monitors sometimes generate "far-out" data—on the average, about five out of every 8,000 readings will be obvious errors. Agri-Growth uses computer algorithms to smooth data and eliminate outlying readings. Following these protocols eliminates the potential for bias to influence results, and performance data is generated under the same conditions that farmers contend with every day.

Once the data is smoothed and outlying readings eliminated, results are plotted based on number of monitor readings and yield. In this way, yield monitor data is made easily decipherable into graphed curves that separate treatment(s) from control. The figure below is an example of how yield readings are developed into smooth curves. In nearly all cases when there is a marked difference between treatment and control readings, graphed curves will offset one another, with lower yield readings and frequency of occurrence appearing to the left of the treatment curve. When positive effects from treatments are achieved, readings of treated strips will also appear in a narrower band than control strips. This is because treatments have a uniforming effect on reducing stress to plants, allowing them to better utilize their genetic yield potential

The figure below gives an example of a yield monitor reading comparisons for product study.



Yield monitor reading comparisons for product study.

Agri-Growth's concept research also provides an interpretation of Return on Investment (ROI). ROI is a calculation of the actual dollars earned from yield gain or loss due to the use of products, services, farming practices, etc.

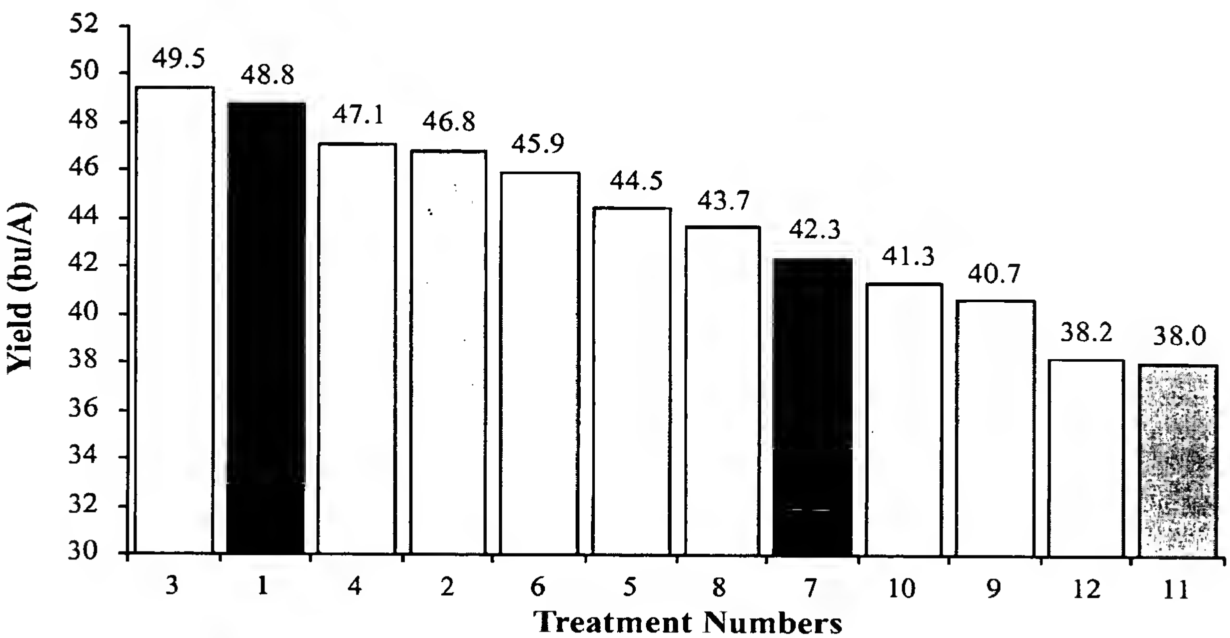
Conclusion: Soybean Yield Increase 26% with Naturize

Naturize increased soybean yields by 26%, or 10 bushels per acre, compared to control.

Naturize (Treatment 1 & 3) averaged yields of 49.2 bu/A compared to the untreated control (Treatment 11) of 38.0 bu/A, an increase of 11.2 bu/A.

Naturize (Treatment 4 & 2) averaged yields of 46.9 bu/A compared to the untreated control (Treatment 11) of 38.0 bu/A, an increase of 8.9 bu/A.

Evaluating the Effect of Naturize™ on Soybean Development and Yield



Evaluating the Effect of Naturize™ on Soybean Development and Yield

Research Results

This study evaluates the products' ability to influence yield response. A 80 acre field was planted with soybean variety, WFP 8170 on May 20, 2001 (141,000 SPA) in 22 foot wide strips 1,000 feet long. Treated strips were alternated with control strips in five replicates and comparisons tracked throughout the season and harvest. The average soil texture in these strips is loamy with an average CEC of 14.3 and average pH of 7.1.

Growing Season

Normal Planting Date and Below-Normal Heat Unit Accumulations – GDU accumulations were below normal through June, with normal GDU and excellent field drying conditions at the end of the season.

High Early Season Rainfall – After planting, rainfall in May and June was above normal, resulting in crop stress following emergence.

Stand Establishment and Crop Maturity – Extremely dry soil moisture levels after mid-June due to ~ one rain event per month until crop maturity.

Yield Results

The yield map (pagc 6) of this study is a valuable tool to show the yield variances that occurred. However, the map by itself is difficult to interpret. For example, one does not see strips of light blue for the Naturize™ treated areas and strips of red for control areas. Mapping software assigns a range of colors for yield levels and there may be no pattern related to the treatments. A more precise method to analyze the data is to use math and graph the results.

The line graph shows how the yield monitor data in the map can be graphed into easier to understand smooth curves (page 7). The data shows that the average yield for Naturize™ (green) treatment was 49.5 bu/A, the midpoint average within the Naturize™ monitor readings inside the green curve. The average for Control (red) shifts to the left where the midpoint average is 38.0 bu/A, based on all of the monitor readings within the red curve.

The Bottom Line

The bar chart shows the bushel per acre yield advantage (page 8), a grower may likely see if he decides an application of Naturize™ is appropriate under field conditions similar to those in the study.

Statistics

The Duncan's multiple range test (DMRT) as shown on the last page (page 10), is used to determine if significant differences have occurred between treatments. This test indicates statistical separation between the twelve treatments as follows: 49.5 bu/A (a), 48.8 bu/A (a), 47.1 bu/A (ab), 46.8 bu/A (ab), 45.9 bu/A (ab), 44.5 bu/A (ab), 43.7 bu/A (b), 42.3 bu/A (b), 41.3 bu/A (c), 40.7 bu/A (c), 38.2 bu/A (c), and 38.0 bu/A (c).

DUNCAN'S MULTIPLE RANGE TEST (DMRT)

A statistical evaluation of the studies was conducted using the Duncan's Multiple Range Test (DMRT). The DMRT allows you to evaluate statistical differences between treatments and the probability that those differences are real and not due to chance. The ninety-five percent level of confidence was used. If treatments are significantly different, they will be followed by different letters (a, b, c). This means that ninety-five percent of the time, under similar parameters, these differences among treatments should occur.

Soil Analysis Test Site[1]

Organic Matter (%)	Phosphorous (ppm)		Potassium (ppm)	Magnesium (ppm)	Calcium (ppm)	Soil pH
	P_1	P_2				
3.8	38	57	273	182	1,615	7.1

Buffer Index (pH)	CEC (meg/100 g)	%K	%Mg	%Ca	%H
---	14.3	11.1	17.7	71.2	0

[1]The soil analysis report is an average of 10— 2.5 acre grid samples.

Evaluating the Effect of Naturize™ on Soybean Development and Yield – 2001

Project Code: S-02
Sponsor: Naturize BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.

Site Layout

Length of Field
1,000 Feet or more

1 Replicate

22'

1. A + C — IFT (30 oz/A + 30 oz/A)
2. A + C — IFT/WI (30 oz/A + 30 oz/A)
3. B + C — IFT (30 oz/A + 30 oz/A)
4. B + C — IFT/WI (30 oz/A + 30 oz/A)
5. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A)
6. A + B + C — IFT/WI (30 oz/A + 30 oz/A + 30 oz/A)
7. C — IFT (30 oz/A)
8. C — IFT/WI (30 oz/A)
9. B + C — OST (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
10. B + C — OST/WI (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
11. Control
12. Control — WI

- Planted soybean variety (WFP 8170) on May 20, 2001 at 141,000 SPA
- Treatment description:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - IFT = In-furrow Treatment
  - OST = On Seed Treatment
  - WI = With Inoculant
- 80 acre field; 5 replicates

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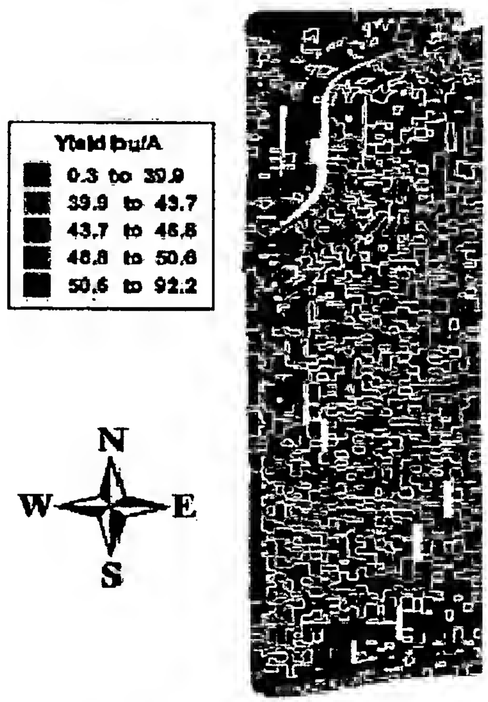
Evaluating the Effect of Naturize™ on Soybean Development and Yield – 2001 (Yield Map)

Project Code: S-02
Sponsor: Naturize BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.

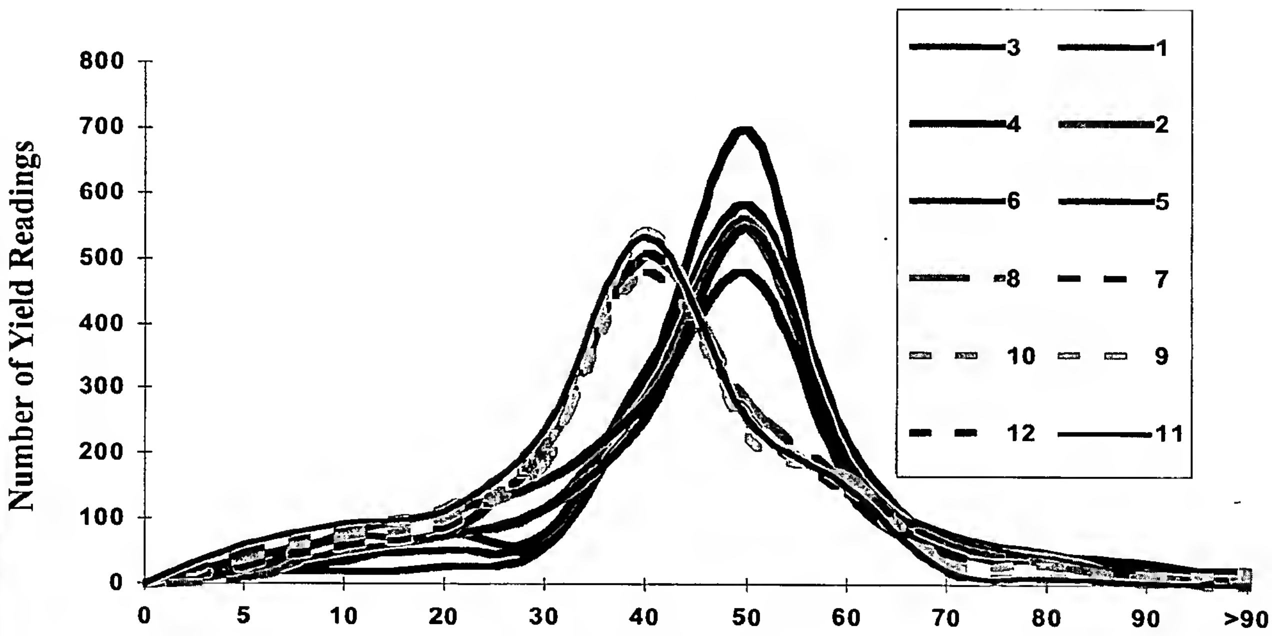


- Planted soybean variety (WFP 8170) on May 20, 2001 at 141,000 SPA
- Treatment description:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - IFT = In-furrow Treatment
  - OST = On Seed Treatment
  - WI = With Inoculant
- 80 acre field; 5 replicates

Evaluating the Effect of Naturize™ on Soybean Development and Yield – 2001 (Yield Monitor Reading Comparison)

Project Code: S-02
Sponsor: Naturize BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.



- Planted soybean variety (WFP 8170) on May 20, 2001 at 141,000 SPA
- Treatment description:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - IFT = In-furrow Treatment
  - OST = On Seed Treatment
  - WI = With Inoculant
- Treatment numbers:
  1. A + C — IFT (30 oz/A + 30 oz/A)
  2. A + C — IFT/WI (30 oz/A + 30 oz/A)
  3. B + C — IFT (30 oz/A + 30 oz/A)
  4. B + C — IFT/WI (30 oz/A + 30 oz/A)
  5. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A)
  6. A + B + C — IFT/WI (30 oz/A + 30 oz/A + 30 oz/A)
  7. C — IFT (30 oz/A)
  8. C — IFT/WI (30 oz/A)
  9. B + C — OST (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
  10. B + C — OST/WI (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
  11. Control
  12. Control — WI
- 80 acre field; 5 replicates

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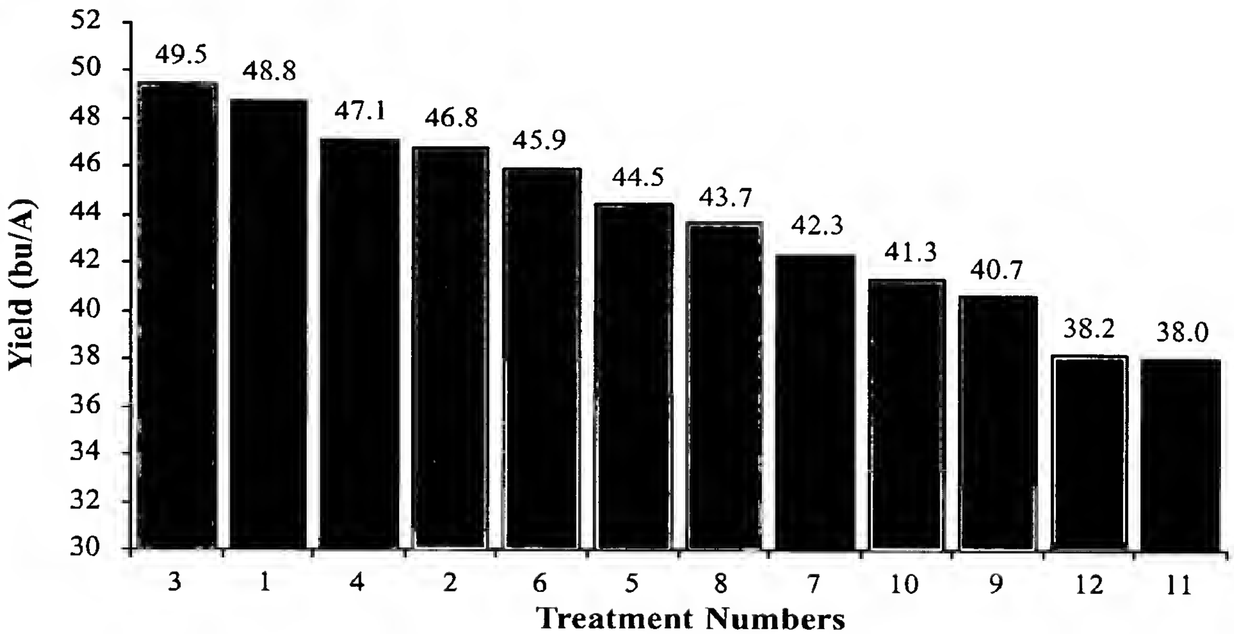
Evaluating the Effect of Naturize™ on Soybean Development and Yield – 2001 (Yield Results)

Project Code: S-02
Sponsor: Naturize BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.



- Planted soybean variety (WFP 8170) on May 20, 2001 at 141,000 SPA
- Treatment description:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - IFT = In-furrow Treatment
  - OST = On Seed Treatment
  - WI = With Inoculant
- Treatment numbers:
  1. A + C — IFT (30 oz/A + 30 oz/A)
  2. A + C — IFT/WI (30 oz/A + 30 oz/A)
  3. B + C — IFT (30 oz/A + 30 oz/A)
  4. B + C — IFT/WI (30 oz/A + 30 oz/A)
  5. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A)
  6. A + B + C — IFT/WI (30 oz/A + 30 oz/A + 30 oz/A)
  7. C — IFT (30 oz/A)
  8. C — IFT/WI (30 oz/A)
  9. B + C — OST (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
  10. B + C — OST/WI (4 oz/100 lbs of seed + 4 oz/100 lbs of seed)
  11. Control
  12. Control — WI
- 80 acre field; 5 replicates

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Evaluating the Effect of Naturize™ on Soybean Development and Yield – 2001 (Yield Results)

Project Code: S-02
Sponsor: Naturize BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.

Treatments	Rate	Yield bu/A
3. B + C — IFT	30 oz/A + 30 oz/A	49.5 a
1. A + C — IFT	30 oz/A + 30 oz/A	48.8 a
4. B + C — IFT/WI	30 oz/A + 30 oz/A	47.1 ab
2. A + C — IFT/WI	30 oz/A + 30 oz/A	46.8 ab
6. A + B + C — IFT/WI	30 oz/A + 30 oz/A + 30 oz/A	45.9 ab
5. A + B + C — IFT	30 oz/A + 30 oz/A + 30 oz/A	44.5 ab
8. C — IFT/WI	30 oz/A	43.7 b
7. C — IFT	30 oz/A	42.3 b
10. B + C — OST/WI	4 oz/100 lbs of seed + 4 oz/100 lbs of seed	41.3 c
9. B + C — OST	4 oz/100 lbs of seed + 4 oz/100 lbs of seed	40.7 c
12. Control — WI		38.2 c
11. Control		38.0 c

Means followed by the same letter do not significantly differ (P = .05 Duncan's MRT)

- Planted soybean variety (WFP 8170) on May 20, 2001 at 141,000 SPA
- Treatment description:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - IFT = In-furrow Treatment
  - OST = On Seed Treatment
  - WI = With Inoculant
- 80 acre field; 5 replicates

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Appendix V.

Comparative Evaluation of Naturize Products on Turfgrass (2003)

PROJECT REPORT

TO

NATURIZE BIOSCIENCES, INC.
11737 CENTRAL PARKWAY
JACKSONVILLE, FL 32224

FROM

SOIL AND WATER SCIENCE DEPARTMENT
P.O. BOX 110510
UNIVERSITY OF FLORIDA
GAINESVILLE, FL 32611

FOR THE PERIOD

1 JUL 2002 THROUGH 30 JUNE 2003

PROJECT LEADER: J.B. SARTAIN

DURATION: 1 YEAR

TITLE: COMPARATIVE EVALUATION OF NATURIZE PRODUCTS ON TURFGRASSES

I. INTRODUCTION:

In the recent past, turfgrass fertilization has received more attention from an environmental perspective. Because of the overall total quantity of fertilizer required to maintain an acceptable quality turfgrass many environmentally concerned individuals have questioned the environmental soundness of our turfgrass fertilization practices. Due to the cultural practices involved in turfgrass management and the unique nutritional requirements of turfgrasses, somewhat higher rates of fertilizer application are common than would be typically utilized on an agronomic crop. The removal of clippings and the efficiency of nutrient uptake limit the quantity of nutrients which might be subject to leaching and serve as a source of water contamination. Since one can not predict the frequency nor intensity of rainfall the total avoidance of nutrient leaching from soluble nutrient sources is almost impossible; therefore, much scientific effort has been exerted to enhance the efficiency of uptake of applied nutrients according to the growth cycle needs of the turfgrasses. Information on the growth and quality response of turfgrasses to these newly synthesized materials is essential. Thus, the following studies are proposed to compare the growth and quality response, total N and P uptake and leaching losses of these new Naturize products with commercially available products using turfgrasses as a test crop.

II. OBJECTIVES:

The objectives of the proposed research are multi-facet and related to individual studies:

A. Growth and Quality Field Study

To compare the growth, quality and N uptake efficiency of Naturize 15-4-7 applied at varying rates with three commercially available turfgrass fertilizers on field grown St. Augustinegrass..

B. Glasshouse Leaching Study

To compare the N and P leaching characteristics Naturize 15-4-7 with three commercially available turfgrass fertilizers in a glasshouse controlled growing environment using St. Augustine turfgrass.

C. Granular Fertilizer plus Wedge Study

To evaluate the influence of Wedge on turfgrass growth, quality, nutrient uptake and nutrient leaching losses when applied to granular fertilizers to Bermudagrasss.

D. Liquid Fertilizer plus Wedge Study

To evaluate the influence of Wedge on turfgrass growth, quality, nutrient uptake and nutrient leaching losses when applied to liquid fertilizers on Bermudagrass..

E. Grow-in Using Wedge

To evaluate the influence of Wedge on rate of turfgrass coverage, root development and dry matter accumulation when applied to both granular and liquid fertilizers. Granular fertilizers will be applied to St. Augustinegrass and liquid fertilizers will be applied to Bermudagrass.

III. **<u>EXPERIMENTAL:</u>**

A. Growth and Quality Field Study: Plots (6 x 9 ft) of St. Augustinegrass was arranged in a randomized complete block design with four replications. Treatments included the following: 1) Three commercially available fertilizer sources (most likely Scotts Turfbuilder, Scotts Bonus-S and a Lesco product) applied at label recommended rates. 2) Naturize (15-4-7) applied at 100, 75 and 50% of the labeled rate of the competitor products. This generated a total of six treatments. Utilizing four replications of the treatments generated a total of 24 experimental units. Treatments were applied on a monthly basis for four months. Clippings for growth rate and nutrient uptake (N, P and K) were taken every 30 days just prior to the next treatment application. Visual quality ratings were taken weekly.

B. Glasshouse Leaching Study: This study evaluated the effects of leaching only. No attempt was made to evaluate runoff in light of previous studies where virtually no runoff was collected on a sloping sand grow-in study. For the most part our studies have suggested that very little if any runoff occurs in a mature turfgrass setting. This study was established in controlled environment glasshouse setting using lysimeters to evaluate the leaching properties of the fertilizer

materials. Turfgrass was established on the surface of PVC lysimeters (6 inches diameter by 18 inches deep) by sodding them with cut pieces of St. Augustinegrass turf. Treatments were applied following a two week establishment period. The same six treatment outlined in the Growth and Quality Field Study were used in this study. Four replications of the treatments were arranged in a randomize complete block design and were rotated on a weekly basis within blocks to minimize the location effects of the glasshouse. The study was run for a total of 16 weeks. Clippings for dry weight and nutrient uptake (N, P and K) were taken monthly (or more often if excessive growth occurs). Leachates were collected every 30 days just prior to the next fertilizer application by applying ? pore volume of water and analyzed for NO_3-N, NH_4-N, P, and K.

C. Granular Fertilizer Plus Wedge Study: Bermudagrass were sodded to tubs (18 inches by 24 inches) in a controlled glasshouse environment. Tubs were mounted at a 10 degree angle and a hole was cut in the bottom for leachate collection. After a two week establishment period treatments were applied in a randomized complete block design and replicated four times. Five treatments (1. Fertilizer - No Wedge, 2. 100% Fertilizer rate + Wedge, 3. 75% Fertilizer rate + Wedge, 4. 50% Fertilizer rate + Wedge and 5. Wedge alone) were applied on a monthly basis. Clippings for growth rate and nutrient uptake (N, P and K) were taken every 30 days for a total of 4 harvests or 120 growth days. Quality ratings were taken weekly. Leachates were taken by applying ? pore volume of water every 30 days. Leachates were analyzed for NO_3-N, NH_4-N, P and K.

D. Liquid Fertilizer Plus Wedge Study: This study was conducted the same as C. Granular Fertilizer Plus Wedge Study except a liquid fertilizer was used.

E. Grow-in Using Wedge Study: Potentially the period of greatest environmental impact due to turfgrass fertilization occurs during grow-in because of the lack of coverage by the turfgrass and the high rates of fertilization and irrigation used. This study evaluated the influence of a biological material on grow-in rate and nutrient uptake efficiency of St. Augustinegrass and bermudagrass. Tubs (the same dimensions as above) were sprigged to bermudagrass at the standard sprigging rate of 20 bushels per 1000 sq ft. A total of five treatments were applied to St. Augustinegrass using a granular fertilizer formulation and to Bermudagrass using a liquid formulation on a weekly basis as follows: 1. 1 lb N Granular Fertilizer; 2. 1 lb N Granular

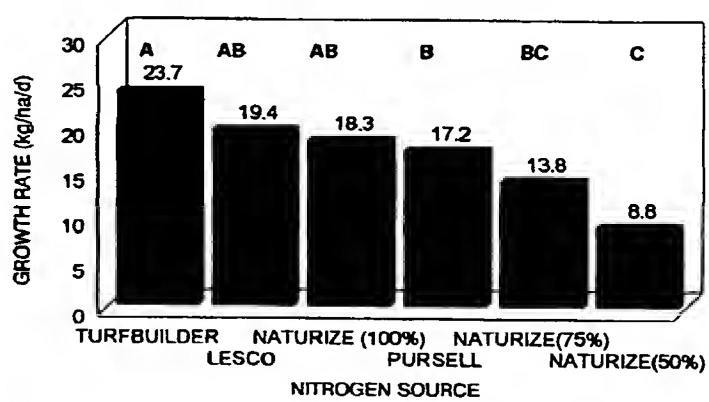
Fertilizer + Wedge; 3. 0.75 lb N Granular Fertilizer + Wedge; 4. 0.5 lb N Granular Fertilizer + Wedge; 5. Wedge alone. 6. 1 lb N Liquid Fertilizer; 7. 1 lb N Liquid Fertilizer + Wedge; 8. 0.75 lb N Liquid Fertilizer + Wedge; 9. 0.5 lb N Liquid Fertilizer + Wedge; and 10. Wedge. Treatments 1-5 were applied to St. Augustinegrass and 6-10 were applied to Bermudagrass. Rating for degree of coverage was taken weekly until full coverage was attained. Experimental units were maintained for a total of 12 weeks. Under normal grow-in conditions complete coverage is generally attained within 42-54 days. Clippings were collected for dry matter accumulation and nutrient uptake (N, P, K) as required or every 30 days after complete coverage was attained. Leachates were collected weekly and analyzed for NO_3-N, NH_4-N, P and K. At termination roots were extracted from the soil, dried and weighed for dry root mass.

IV. RESULTS AND DISCUSSION:

A. Growth and Quality Field Study: Growth Response. In this field study Naturize (15-4-7) was compared to other commercially available turfgrass fertilizers relative to growth and quality responses on an established stand of St. Augustine grass. Materials were applied to recommendations on the bagged fertilizers. In general the rate of N application was approximately one pound of N/1000 sq ft every 30 days. Clippings were collected every 30 days just prior to the next fertilizer application. Visual ratings were taken weekly for color and quality. Basically the same grouping for individual monthly growth estimates was obtained for the overall average growth estimate; therefore, the mean growth rate for the entire growth period is

FIGURE 1.

EFFECT OF N SOURCE ON ST. AUGUSTINE GROWTH

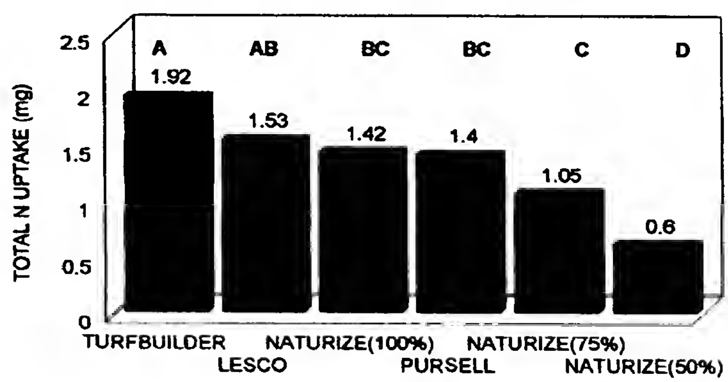


presented in figure 1. On a relative growth basis Turfbuilder (27-3-4) produced the largest mean growth rate when applied at the recommended rate of 1.25 lbs N/1000 sq ft/30 days. St. Augustine growth response to Naturize (15-4-7) applied at 100% recommended N rate did not differ statistically from the Turfbuilder response. In most cases maximum growth is not a desired trait of the nutrient source because this may result in additional mowing expense. Application of the Naturize product at 75 and 50% of the recommended rate did result in reduced growth. A somewhat substantial reduction in growth was observed when the Naturize product was applied at 50% of the recommended rate this growth rate may not be sufficient to sustain quality turfgrass.

N Uptake. Clippings were dried and analyzed for N uptake. These values can not be construed as total N uptake because total growth of the St. Augustine was not evaluated. Clippings were collected monthly at the end of the fertilization cycle. But the values do represent the total uptake of N during that growth evaluation period and comparisons among treatments can be made. Additionally, the total uptake for the four evaluation cycles was calculated and the mean values are presented in figure 2. As might be expected, the N uptake followed a similar relative statistical grouping as the growth rate. Turfbuilder supplied more total N to the St. Augustine followed by Lesco, Naturize (100%), and Pursell when applied at recommended N rates. Reducing the rate of applied N for the Naturize product to 50% resulted in less than 2% N in the tissue (1.59-1.83% N) which would be considered as deficient in most situations.

FIGURE 2.

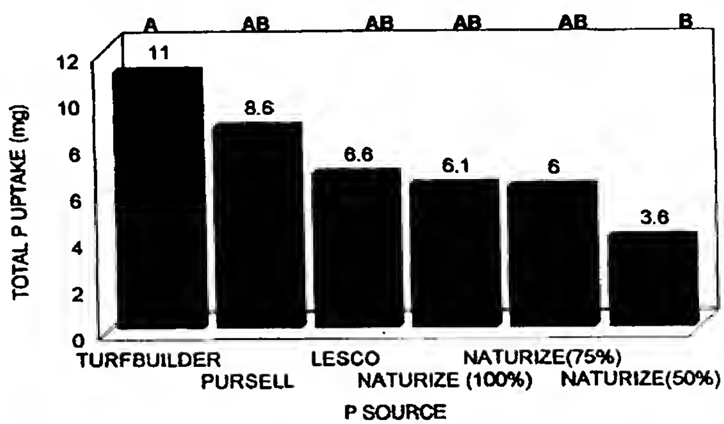
EFFECT OF N SOURCE ON ST. AUGUSTINE N UPTAKE



P Uptake. St. Augustine tissue was also analyzed for P. Total P uptake was calculated in the as manner as described for N above and the mean P uptake is presented in figure 3. The P status of the tissue was high ranging from (.47 to .66%). The soil at the location is a phosphatic soil which is high in Mehlich I extractable P, thus the relatively high tissue P levels. Even though the soil was high in extractable P differences in total P uptake relative to fertilizer source were still noted. Turfbuilder once again supplied the greatest quantity of nutrient. This is most likely more related to the total quantity of growth produced by this fertilizer source than to the availability of P. Phosphorus was not limiting in any of the plots so total P uptake was a function of total growth and not P availability.

FIGURE 3.

EFFECT OF P SOURCE ON ST. AUGUSTINE P UPTAKE

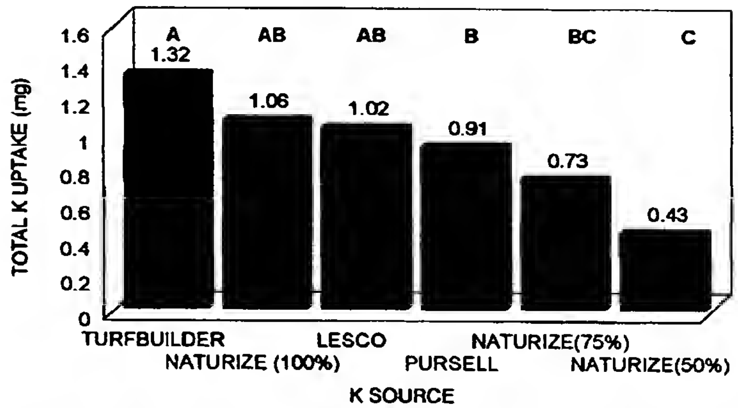


K Uptake. St. Augustine tissue K concentration ranged from 0.87 to 1.55% K during the course of the study. In previous research a tissue K concentration of less than 1.0% has been considered as deficient. Mean total K uptake as presented in figure 4 was calculated in the same fashion as N and P. Turfbuilder once again supplied the largest quantity of total K to the St. Augustine turfgrass followed closely by Naturize (100%) and Lesco. These results may have been strongly influenced by the growth rate of the turfgrass but it appears that they were also influenced by the quantity of K in the fertilizer mixture. Naturize and Lesco products contained the largest quantity of K and were ranked higher in total K uptake. The superior K uptake rating for Turfbuilder was most likely related to the high total growth response that was observed as a

result of the application of this product. In harvests 2, 3 and 4 application of the Naturize (100%) product produced the highest level of K in the tissue ranging from 1.2 to 1.5% K. These are desirable levels of tissue K and are well within in the sufficiency range for optimum growth.

FIGURE 4.

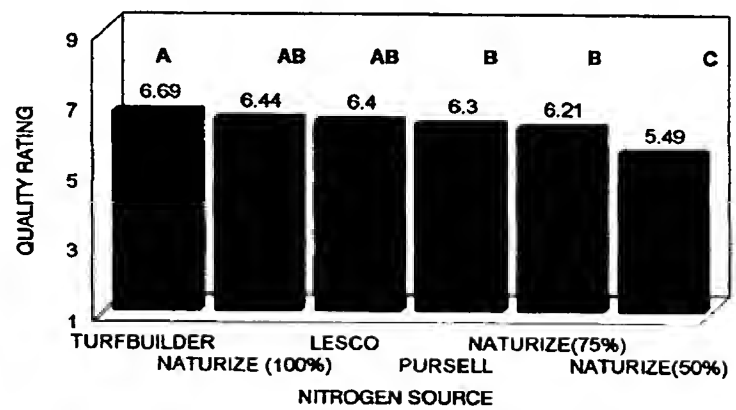
EFFECT OF K SOURCE ON ST. AUGUSTINE K UPTAKE



Average Visual Ratings. Visual ratings for quality and density were taken weekly. During the course of the study period statistical groupings for the individual ratings did not differ from the overall mean statistical grouping; therefore, the mean statistical groupings relative to applied N source are shown in figure 5. A rating of 5.5 is considered as the minimum acceptable turfgrass quality. Most of these fertilizer sources maintained a turfgrass quality of greater than 5.5, thus acceptable quality was maintained. As shown in figure 1 Naturize did not produce the maximum growth but it did sustain a very high quality when applied at 100% the recommended rate. In fact, a mean quality of greater than 6.0 was sustained by the application of only 75% of the recommended rate for the Naturize product. It does not appear that the

FIGURE 5.

EFFECT OF N SOURCE ON ST. AUGUSTINE QUALITY

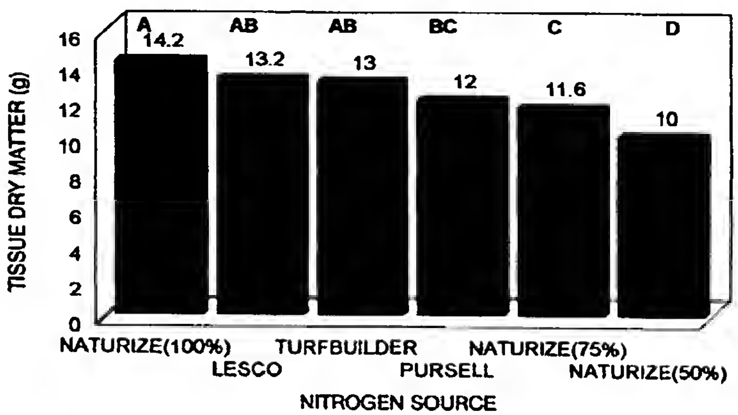


application of only 50% of the recommended rate of Naturize (15-4-7) will sustain acceptable growth and quality.

B. Glasshouse Leaching Study: Total Tissue Yield. Tissue was collected a total of five times during the 16 weeks of the study for growth and uptake analysis. Total clipping yields were recorded as dry mass and are expressed in grams. As shown in figure 6, Naturize (100%) produced the maximum yield followed closely by Lesco and Turfbuilder. Pursell product and the two reduced rates of Naturize produced the smallest yields. These growth rates are not that much different from what was observed in the field except in this case the Naturize product produced the maximum yield.

FIGURE 6.

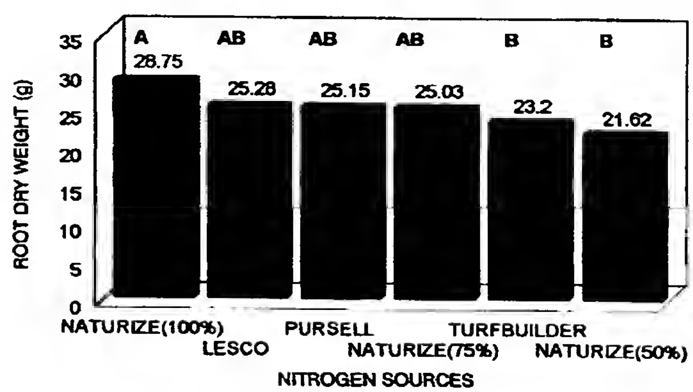
EFFECT OF N SOURCE ON ST. AUGUSTINE DRY MATTER



Root Growth. Roots were extracted from the soil at termination of the study, dried and weighted for mass. Nitrogen sources had a significant effect on the total dry mass of roots produced as shown in figure 7. The Naturize product applied at 100% recommended rate

FIGURE 7.

EFFECT OF N SOURCE ON ST. AUGUSTINE ROOT WEIGHT

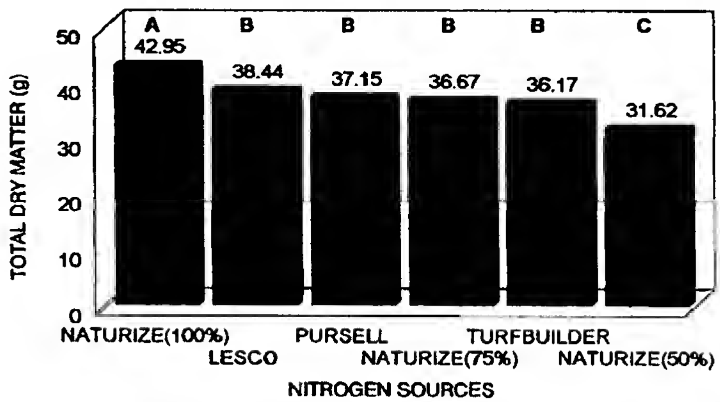


produced the statistical maximum yield followed closely by Lesco, Pursell and Naturize (75%). It is interesting the Turfbuilder product produced significantly less roots than did the other products when in field studies it produced the most growth. It could be related to the lower levels of P and K that are contained in the Turfbuilder product.

Total Dry Matter Production: Total tissue dry matter mass was combined with the root dry matter mass to calculate the total dry matter production. These data are presented in figure 8. The Naturize product applied at 100% of the recommended rate produced the highest total dry matter production. The Lesco, Pursell and Naturize (75%) produced the next highest total dry matter. Turfbuilder and Naturize (50%) produced the least total dry matter. It is interesting that the Naturize (100%) had such a significant and consistent influence on both top and root growth. The Naturize product (15-4-7) more closely mimics the nutritional needs of the turfgrass as has been shown in previous research and this may be one of the reasons for its superior influence on growth in this study.

FIGURE 8.

EFFECT OF N SOURCE ON ST. AUGUSTINE TOTAL DRY MATTER ACCUMULATION



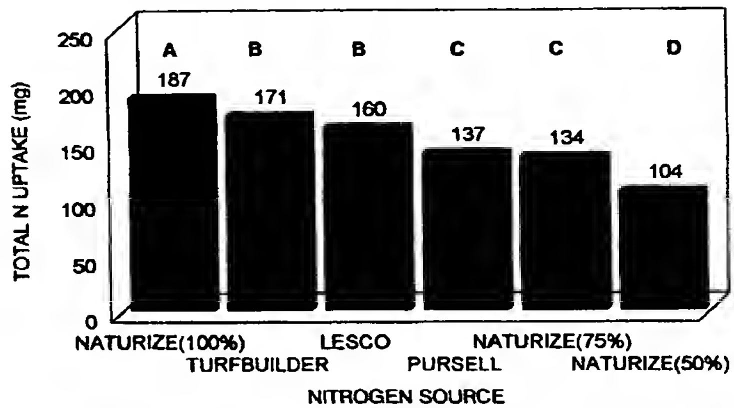
Total N Uptake: In general, the tissue N levels for the five harvests in this study were low and below recommended levels for sufficiency. It should be noted that the harvests were taken at the end of the monthly evaluation period following leaching and prior to the next fertilization, thus the tissue N levels were possibly low because most of the N was leached out prior to uptake. The tissue N levels ranged from 0.77 to 1.65%. The recommended N level for St. Augustine turfgrass is within the range of 2.0 to 2.5%.

Naturize (15-4-7) applied at 100% of the recommended rate produced the largest total N

uptake as shown in figure 9. The Naturize product supplied more total N under these conditions of heavy leaching which suggests that the product should perform well in the field environment where rainfall and excessive irrigation might be practiced. It is interesting that the Turfbuilder product produced superior growth and N uptake results in the field, but in the more controlled glasshouse environment the Naturize product consistently out performed the Turfbuilder product.

figure 9.

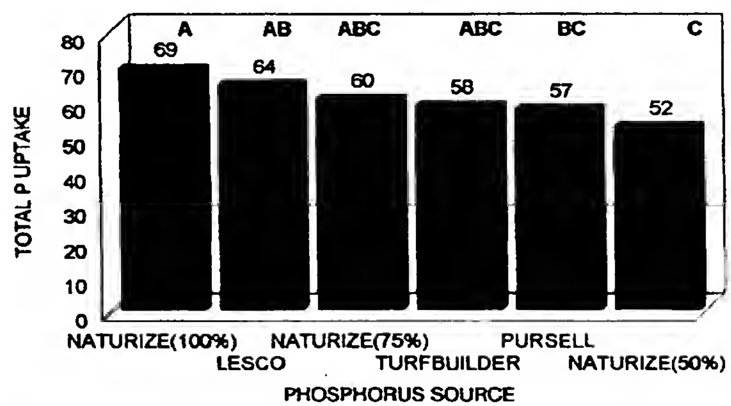
EFFECT OF N SOURCE ON ST. AUGUSTINE N UPTAKE



P Uptake. Foliar tissue was also analyzed for P. In general, the tissue P ranged from 0.4 to 0.5% which is well within the sufficiency range for St. Augustine turfgrass. The same Arredondo fine sand was used in the columns as was used in the field. This is a phosphatic soil which contains relatively high levels of extractable P, thus most of the P was most likely coming from the soil and not from the applied fertilizers. Even though statistical differences in tissue P

FIGURE 10.

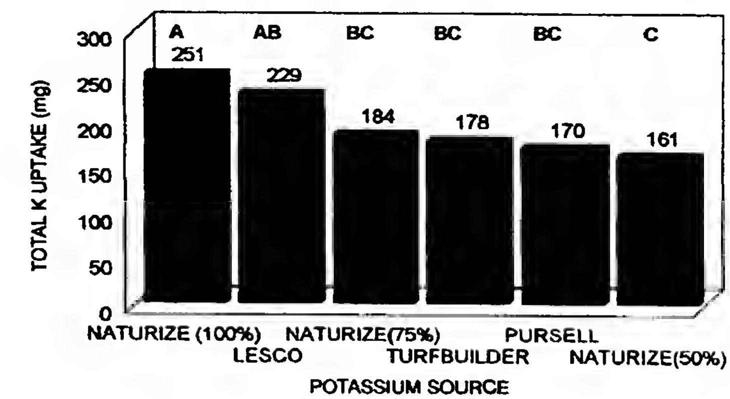
EFFECT OF P SOURCE ON ST. AUGUSTINE P UPTAKE



accumulation exist relative to applied P source realistic differences in total P uptake do not exist in light of the relatively small range over which the differences occur.

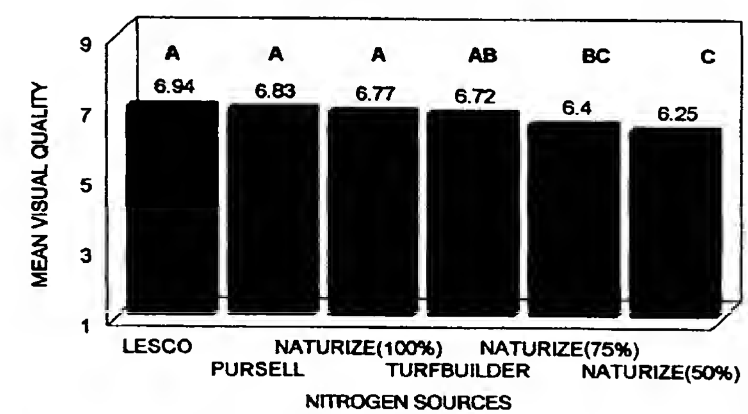
K Uptake. St. Augustine tissue K levels were mostly within the high range for sufficiency ranging from 1.5 to over 2.0 percent K. Total K uptake as influenced by applied K source is shown in figure 11. As was noted for P, real differences in total K uptake relative to K source applied are questionable due to the relatively small range in total K uptake. Total K uptake by the St. Augustine turfgrass followed a similar trend as the N and P and the growth with the Naturize (100%) product producing the largest K uptake.

FIGURE 11.
EFFECT OF K SOURCE ON ST. AUGUSTINE K UPTAKE



Visual Ratings. Visual ratings were taken weekly through out the study period. For the most part the turfgrass was of high visual quality maintaining ratings of greater than 6.0 in most cases. The mean visual quality ratings for the study period are presented in figure 12.

FIGURE 12.
EFFECT OF N SOURCE ON ST. AUGUSTINE MEAN VISUAL QUALITY



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N Leached. A ? pore volume of water was applied near the end of the monthly growth cycle just before the next application of fertilizer. Depending on the fertilizer source but approximately 1.12 to 1.25 lbs of N were applied on a monthly basis. St. Augustine is noted for its efficiency in absorbing applied N. There was no N detected in any form in any of the leachate samples collected. There are two possible reasons for these results. One the period time that passed from application to leaching. Most of the N was most likely taken up by the turfgrass and during the four week growth period. The strong growth properties of the turfgrass and its extensive root system contributed to high N uptake efficiency and the lack of N leaching. Other studies have shown that insignificant quantities of N are lost through leaching of mature St. Augustine grass when approximately 1.0 lbs of N are applied per 1000 sq ft.

P Leached. Very small quantities of P were leached through the columns. The majority of the P leached was in the first leachate collection with the remainder in the second leachate. There was not P in the third and fourth leachate. The total quantities of P leached were as follows: 0.23, 0.07, 0.05, 0.04, 0.02 and 0.01 mg P for Naturize (75%), Naturize (50%), Lesco, Pursell, Naturize (100%) and Turfbuilder, respectively. There were no statistical differences relative to P source and the quantities are not related to the quantity of P applied through treatment. It is believed that most of the leached P is coming from the soil and not the fertilizer source.

K Leached. Potassium was detected in all four leachates but at very small quantities which did not relate to the quantity of K applied in the fertilizer sources. There were no statistical differences in the quantity of K leached relative to applied fertilizer source. The total quantities of K leached were as follows: 11.12, 9.25, 8.73, 7.52, 5.50 and 5.05 mg K for Naturize (75%), Turfbuilder, Naturize(50%), Pursell, Naturize (100%) and Lesco, respectively.

Summary: In this study the Naturize (15-4-7) product applied at 100% the recommended rate of N produced more foliar and root growth and a higher quality turfgrass than did the commercially available materials. This product also supplied more total N, P and K to the turfgrass than did the other materials. None of the N sources leached a measurable quantity of N and only minimal quantities of P and K were leached. The Naturize (15-4-7) appears to be a superior fertilizer for St. Augustine fertilization.

C. Granular Fertilizer Plus Wedge Study n Sodded Bermudagrass: Growth Estimates. Cut sod pieces were placed on 1.5 x 2.0 ft tubs and established for two weeks prior to fertilizer application. A USGA sand mix was used as a growth media. Clippings were collected on a monthly basis for growth and nutrient uptake estimates. Naturize (15-4-7) was applied at 100, 75 and 50% the recommended rate as a granular material. Wedge was applied along with the fertilizer source and as a sole source. A total of six harvests were collected. The foliar clippings were combined for a total tissue dry matter accumulation estimate. These data are presented in figure 13. Unfortunately, it does not appear that the application of Wedge (W) with the Naturize product enhanced growth. The data suggests that growth may have been suppressed somewhat. A reduction in growth relative to the quantity of the Naturize product applied was observed, as might be anticipated, but in this 120 day study the Naturize

FIGURE 13.

EFFECT OF N SOURCE ON BERMUDA TISSUE DRY MASS

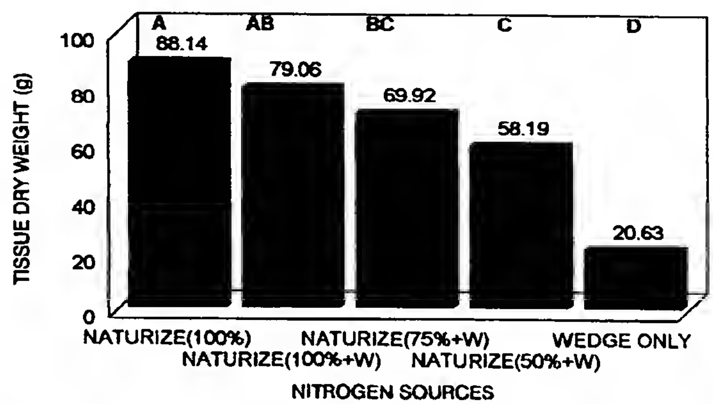
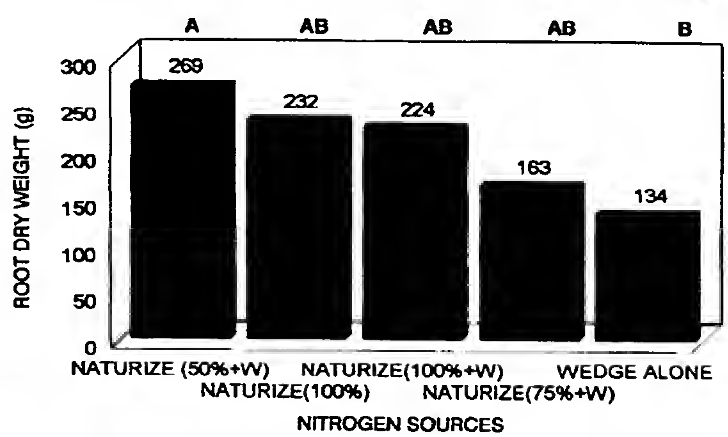


FIGURE 14.

EFFECT OF N SOURCE ON BERMUDA ROOT MASS



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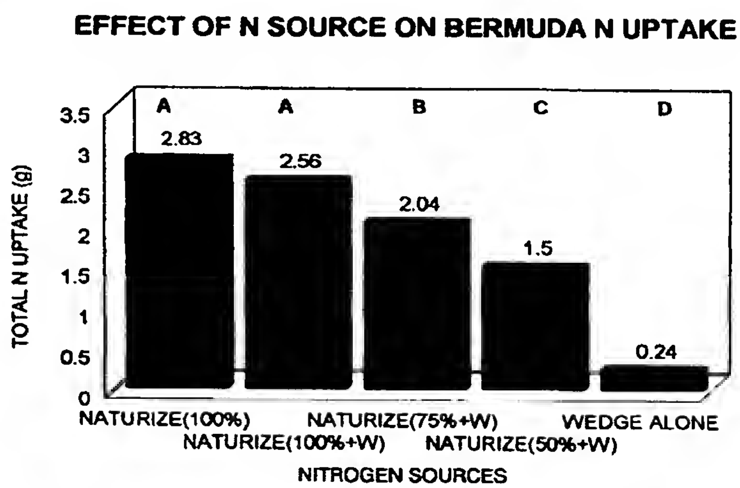
product without the application of Wedge produced the superior growth response.

Root Dry Weight: Root weight as influenced N source is presented in figure 14. Statistical differences in root dry relative to applied treatment exist but they do follow a recognizable pattern. The only real difference in treatment was when Wedge alone was applied and a reduction in root weight was observed. Wedge did not appear to benefit the production of root mass when applied with the granular fertilizer.

Total Dry Matter Accumulation - followed the same trend as the root dry weights relative to applied treatment because of the large quantity of roots produced relative to the foliar tissue. Once again it does not appear that the application of the Wedge product along with the dry granular product produced any real benefit relative to total growth response.

N Uptake: All six clippings collections were analyzed for total N. The tissue ranged from 0.76 to 3.93% N in response to the applied treatments. Total N uptake was calculated based on the quantity of dry matter produced and the concentration of N in the tissue. Treatment effects on bermuda tissue N are presented in figure 15. Total N uptake was significantly influenced by treatment in that the N sources supplying the largest quantity of N produced the most total N uptake, but there did not appear to be any advantage to including Wedge with the granular product. In fact, the statistical maximum N uptake occurred when the Naturize (15-4-7) was applied at 100% of the recommended application rate without the addition of the Wedge material.

FIGURE 15.



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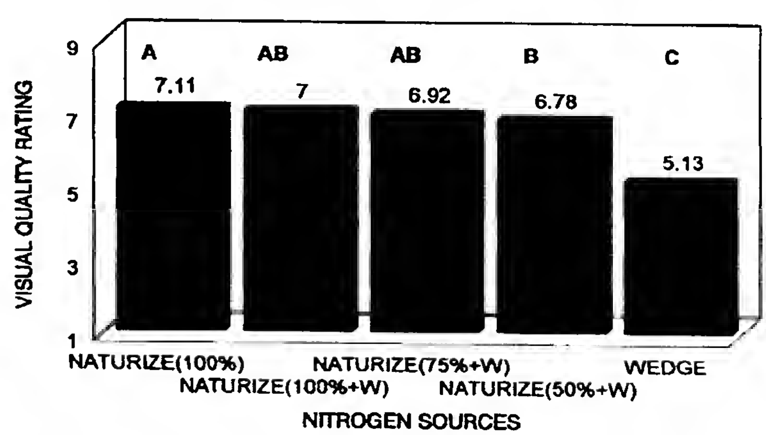
P Uptake. Phosphorus uptake followed a trend very similar to that observed for N. The tissue P levels ranged from 0.33 to 0.45% P which were well within the adequate range. This is interesting in light of the fact that this turfgrass was grown on a USGA sand mix low in P and that very little P was applied in the Wedge treatment. Total uptake of P was 0.40, 0.34, 0.29, 0.23 and 0.7 g P for Naturize (100%), Naturize (100%+W), Naturize (75%+W), Naturize(50%+W) and Wedge alone, respectively.

K Uptake. Potassium uptake followed a trend identical to that of P. Tissue P ranged from 0.51 to 2.06% K with the levels being indicative of the rate of applied K. The largest quantity of K was taken up from the experimental units which received the Naturize (15-4-7) product applied at 100% of the recommended rate without the addition of Wedge. Quantities of K accumulated followed exactly the rate of applied K and did not reflect an advantage in response to the application of the Wedge product.

Visual Ratings. A total of 14 visual ratings were taken during the evaluation period. Bermudagrass quality response was a direct reflection of the rate of applied N, but without an advantage due to the application of the Wedge product. Mean visual quality ratings for the entire growth period are presented in figure 16. Naturize (15-4-7) applied at 100% of the recommended rate without Wedge produced the highest mean quality rating. All of the treatments except for the Wedge alone produced ratings of greater than 6.5 which is indicative of a high quality turfgrass. There did not appear to be any advantage to applying Wedge to the granular formulation, in fact, the quality may have been slightly reduced when the Wedge was

FIGURE 16.

EFFECT OF N SOURCE ON BERMUDA MEAN QUALITY



used.

Leached N. Leachates were collected monthly by applying ? pore volume of water at the end of the four week growth period just prior to the next fertilization. Total quantity of Nitrate and Ammonium- N leached is presented in figure 17. A statistical separation relative to N source and rate in the quantity of N leached was observed during the 120 day study period. Considering that a total of 6810 mg of N was applied and the maximum leached was 50 mg which represents only 0.73% of the total N applied the quantity of N leached was not considered as excessive. However, if one recalls that the 75% rate produced good growth and quality it might be considered the desired N rate because less than 0.2% of the applied N was leached from this

FIGURE 17.

EFFECT OF N SOURCE ON TOTAL N LEACHED FROM BERMUDA SOD

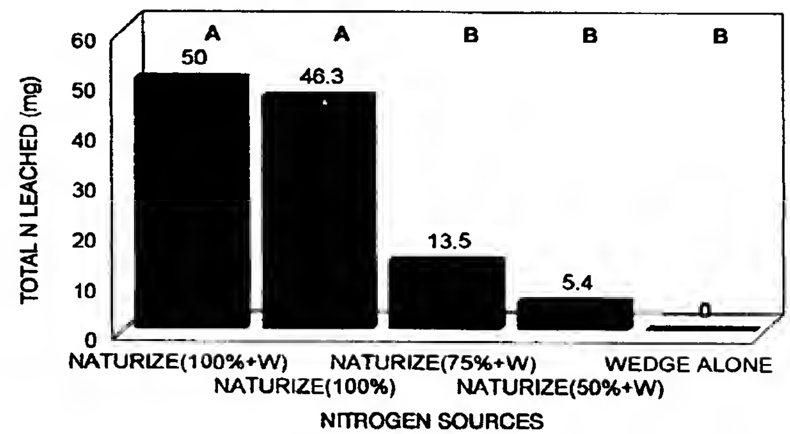
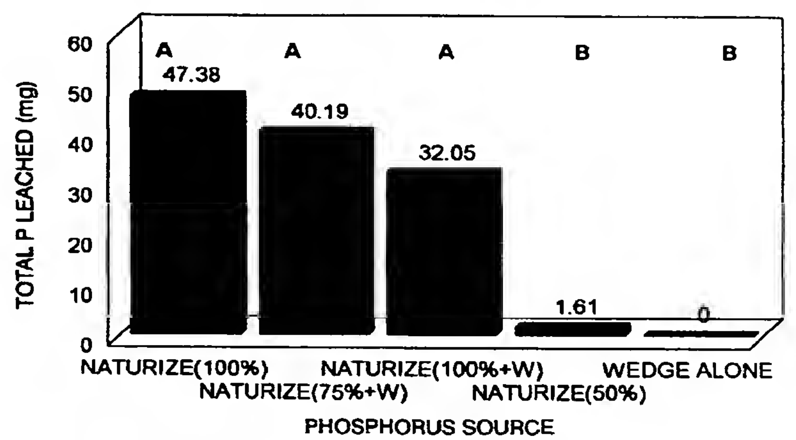


FIGURE 18.

EFFECT OF P SOURCE ON QUANTITY OF P LEACHED FROM BERMUDA SOD

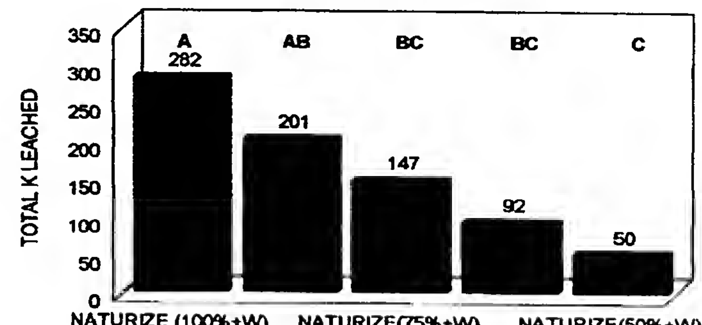


treatment. Application of Wedge along with the granular fertilizer source did not influence the quantity of N lost through leaching.

P Leached. Total quantity of P leached during the 120 day evaluation period is presented in figure 18. Unlike the findings with N, the total quantity of P leached did not exactly follow the rates of applied P. More total P leached from the 75% rate than the 50% rate of application. The values are not statistically different but they do represent a fairly large difference magnitude wise. Relative to N there was much more P leached on an applied basis. Almost 6% of the total P applied leached. This was a sandy soil with very little capacity to retain added P.

FIGURE 19.

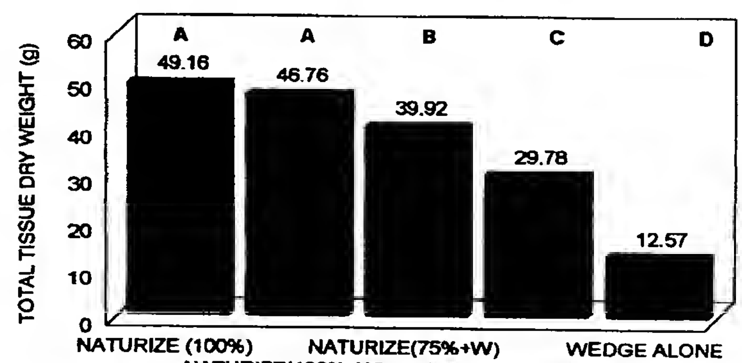
EFFECT OF K SOURCE ON QUANTIY OF K LEACHED FROM BERMUDA SOD



K Leached. Total quantity of K leached is presented in figure 19. A total of 2638 mg of K was added to the experimental units receiving 100% the recommended rate of application. Approximately 10% of the applied K leached during the experimental period. Application of Wedge along

FIGURE 20.

EFFECT OF N SOURCE ON BERMUDA TISSUE DRY MASS



with the granular source did not appear to reduce the K leaching losses, in fact a somewhat larger quantity of K leached from the units receiving Wedge.

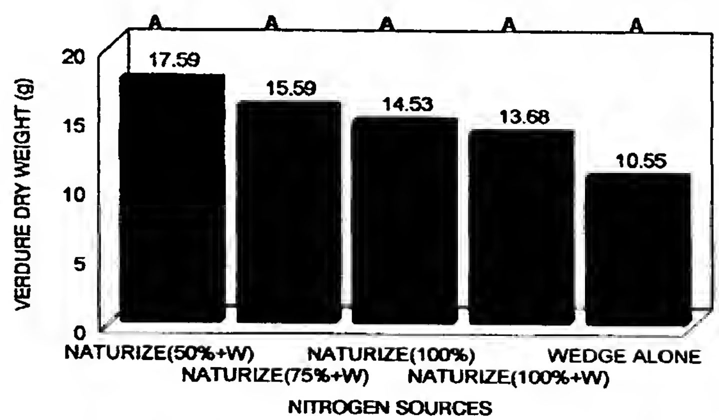
D. Liquid Fertilizer Plus Wedge Study: This study was conducted in the same manner as C. ranular Fertilizer Plus Wedge Study? except in this study a liquid formulation of the Naturize (15-5-10) product was used.

Tissue Growth Estimates. Clippings were collected five times during the 120 day evaluation period. Total growth of the bermuda was collected. Total foliar tissue growth for the 120 day evaluation period is presented in figure 20. Tissue dry matter accumulation responded to the total quantity of N applied. With each decreasing level of N applied there was a corresponding reduction in the quantity of tissue dry matter accumulated. Addition of Wedge to the liquid fertilizer product did not enhance tissue growth.

Verdure Growth Estimates: At termination of the study all the turfgrass tissue below the clipping height was collected and divided into verdure and roots. The quantity of biomass in the verdure is presented in figure 21. Although a reduction in verdure dry weight of almost 50% was observed across the treatments there was no statistical differences due to applied treatments in verdure dry weight. Also, there was no trend relative to applied N in the verdure dry weight. Additionally, there did not appear to be any advantage to using Wedge as a fertilizer supplement.

FIGURE 21.

EFFECT OF NITROGEN SOURCE ON BERMUDA VERDURE



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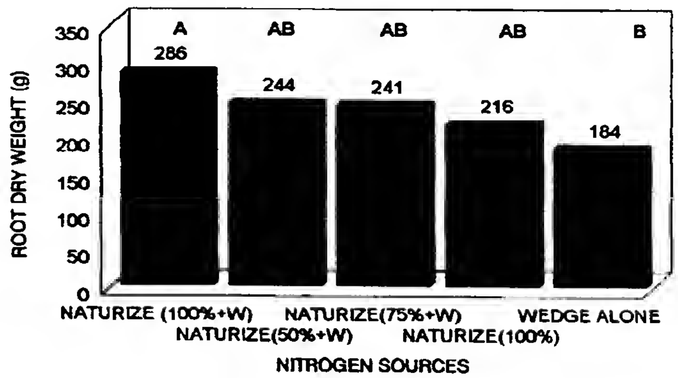
Root Dry Matter Estimates. Roots were washed free of soil and dried at termination of the study for estimates of root dry matter accumulation. Root dry weights as influenced by applied treatments is presented in figure 22. Statistically there was no response to the rate of applied N in that the same grouping was maintained across all the rates of N except for where the Wedge product was applied alone. The reduced growth in response to Wedge alone is thought to be a N deficiency and not directly related to the Wedge alone treatment.

FIGURE 22.

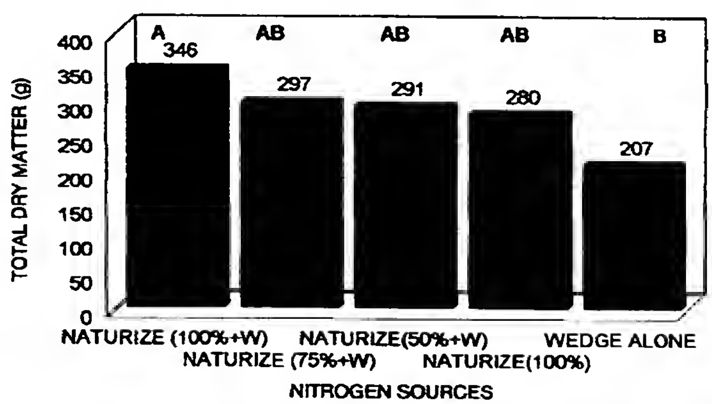
EFFECT OF N SOURCE ON BERMUDA ROOT DRY MASS



Total Dry Matter Yield Estimates. The mass of the clippings, verdure, and roots was combined to generate an estimate for total dry matter yield. Total dry matter of the bermudagrass as influenced by the N source applied is presented in figure 23. Because the root mass was so much larger than the two other components of the dry matter accumulation the trends relative to treatment effects were the same for the total dry matter mass as it was for the dry mass of roots. Statistically there were no differences observed in relative to the rate of applied N. There appears to be a positive

FIGURE 23.

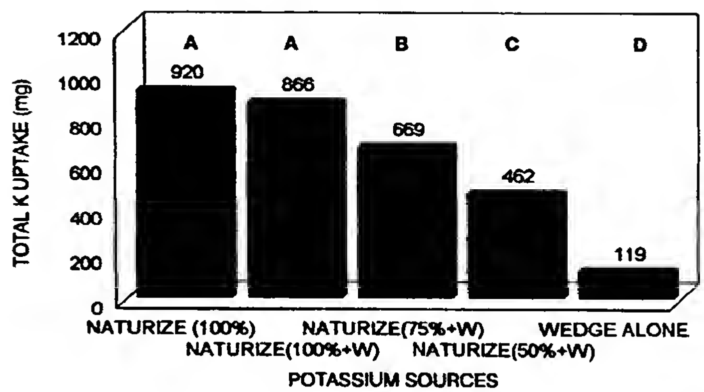
EFFECT OF N SOURCE ON BERMUDA TOTAL DRY MATTEI ACCUMULATION



quantity of P taken up. Once again the liquid applied at 100% the recommended rate without Wedge produced a superior uptake magnitude wise for P. Phosphorus uptake for the 100% recommended rate was not statistically different from the 100% recommended rate plus Wedge application, thus there was no notable advantage to applying Wedge to enhance P uptake. These data are presented in figure 25.

FIGURE 26.

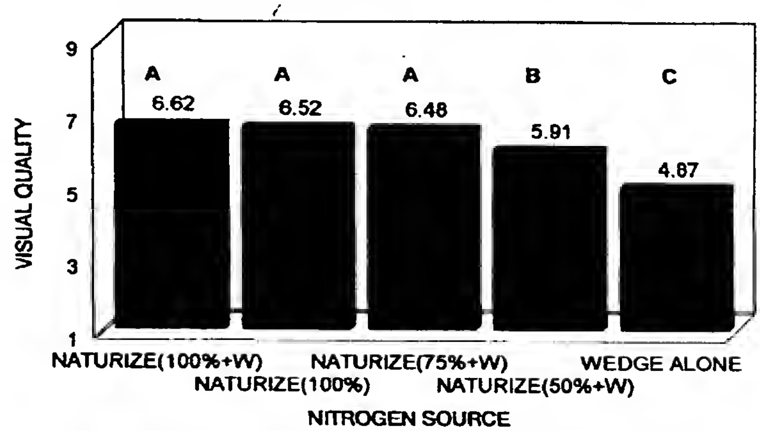
EFFECT OF K SOURCE ON BERMUDA TOTAL K UPTAKE



K Uptake. Total K uptake followed the same trend as N and P relative to effect of treatment. These data are presented in figure 26. Application of Wedge along with the liquid fertilizer source did not enhance the total K taken up or the K status of the turfgrass.

FIGURE 27.

EFFECT OF N SOURCE ON BERMUDA QUALITY



Visual Quality Ratings. Visual quality ratings were taken weekly during the study for a total of 13 observations. Mean visual quality as influenced by applied treatments is presented in figure 27. Visual quality ratings

followed mostly the trend in applied N. The higher the rate of applied N the higher the visual quality. Except for the 75% rate of application which statistically produced the same level of quality as the 100% N rate. Application of Wedge did not appear to enhance quality and when applied alone an inferior undesirable quality of bermudagrass turf was attained.

N Leached. Leachates were collected four times during the course of the study. Each time just prior to the next application of fertilizer. Very little N leached during the 120 day period. In fact, no N was detected in the first two leachates. Relatively small quantities were detected in the four leachate. The vast majority of the N appeared in the third leachate. The quantities of N in the four leachates were as follows: 7.7, 6.5, 1.4, 1.3 and 0 mg N for Naturize (100%+W), Naturize (100%), Naturize (50%+W), Naturize (75%+W) and Wedge Alone, respectively. Wedge application had no effect on the quantity of N leached.

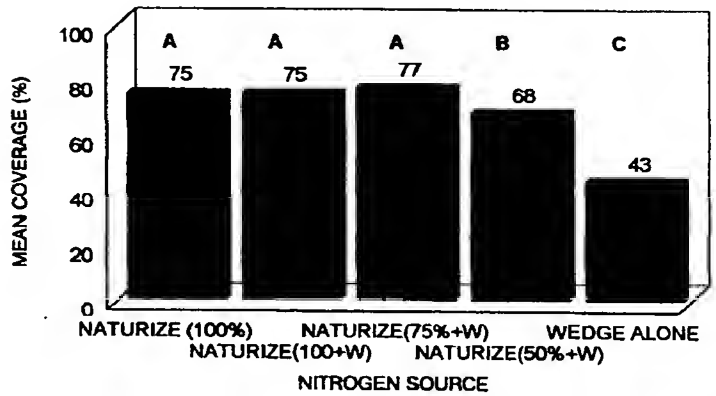
P Leached. Small quantities of P were detected in all four leachates. However, the total quantity of P leached was relatively small. The quantities of P leached for the Naturize (100%), Naturize (100%+W), Naturize (75%+W), Naturize (50%+W) and Wedge Alone were 9.6, 7.0, 5.5, 3.8 and 1.2, mg P, respectively. Quantities of P leached followed the rate of applied P and no effect of Wedge application was observed.

K Leached. Somewhat larger quantities of K were leached during the 120 day study than N and P. Statistical differences in quantities of K leached generally followed the rate of application of K. The quantities of K leached for the Naturize (100%+W), Naturize (100%), Naturize (50%+W), Naturize (75%+W) and Wedge Alone were as follows: 365, 359, 256, 242 and 172 mg K, respectively. No effect of Wedge application on the quantity of K leached was observed.

E. Grow-in Using Wedge Study: St. Augustine C verage Rates. St. Augustine grass was sprigged to tubs in this study and the rate of coverage as influenced by fertilizer application was evaluated. Percentage of coverage was estimated over a six week period. Application of the granular 15-4-7 alone resulted in the fastest rate of coverage with 100% coverage being attained in five weeks after sprigging. By six weeks after sprigging treatments Naturize 100% +W and Naturize 75% +W had attained 100% coverage. Mean coverage rates were calculated over the six period and these data are presented in figure 28.

FIGURE 28.

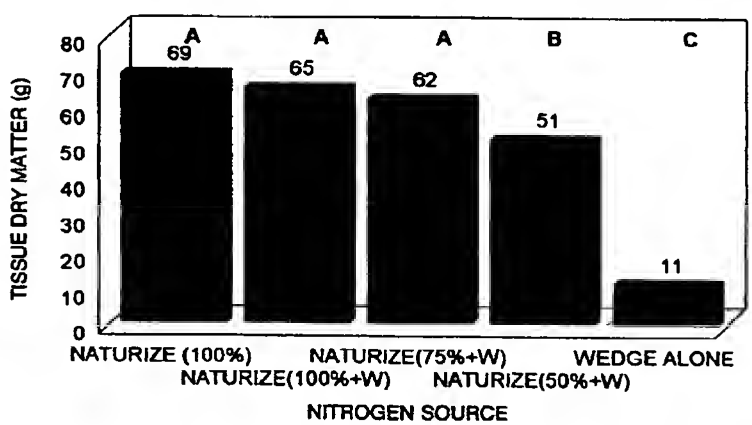
EFFECT OF N SOURCE ON ST. AUGUSTINE COVERAGE



Total Tissue Yield. Clippings were collected six times during the study and dried for dry matter accumulation estimates. As anticipated reducing the rate of applied N reduced the total tissue growth, except in the case of the 75% application rate which produced a tissue mass comparable to that of the 100% rate. Inclusion of Wedge in the granular

FIGURE 29.

EFFECT OF N SOURCE ON ST. AUGUSTINE TISSUE MASS



fertilizer did not appear to enhance tissue dry matter accumulation. The effect of N source on tissue dry matter accumulation is presented in figure 29.

Root Dry Matter Estimates. Roots were washed free of soil and dried for dry matter estimates at the termination of the study. Root weights as influenced by applied treatments are presented in figure 30. There were no statistical differences in root dry matter accumulation in response to N rates. A significant reduction in root dry matter was observed when Wedge alone was applied apparently due to the lack of N. An identical trend in response was observed in the total dry matter mass of the clippings and roots as was observed in the root response because of the magnitude of the root mass. Since the response to treatment in total tissue mass is the same as observed for the roots the total tissue mass will not be presented.

FIGURE 30

EFFECT OF N SOURCE ON ST. AUGUSTINE ROOT DRY WEIGHT

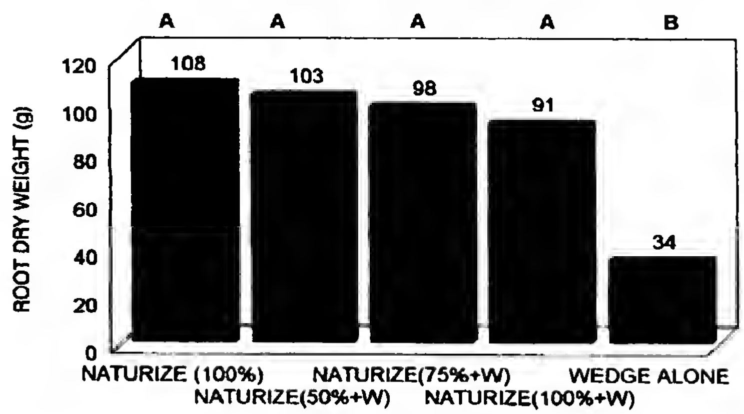
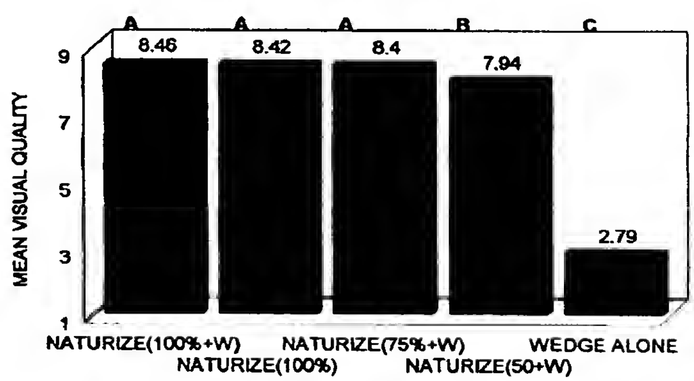


FIGURE 31.

EFFECT OF N SOURCE ON ST. AUGUSTINE MEAN VISUAL QUALITY



Visual Quality Ratings. Ratings for visual quality were taken thorough out the experimental

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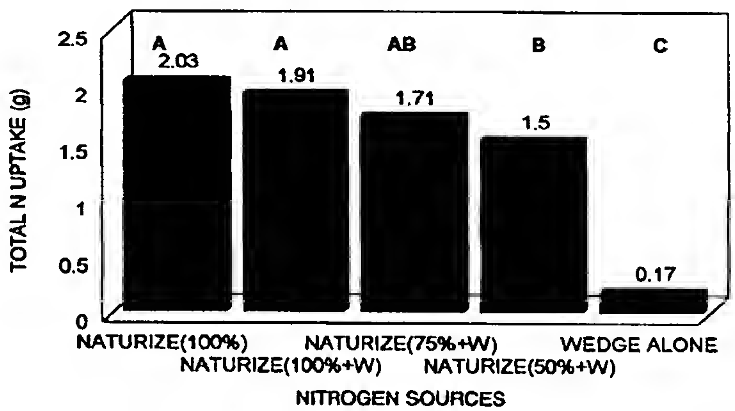
period. Means for visual quality were calculated according to treatment effects and the results are presented in figure 31. Once again the first three treatments produced the highest overall ratings with the 75% N rate being statistically equal to the 100% N rate. As the applied N rate declined below the 75% application rate the mean visual quality of the St. Augustine grass declined. Inclusion of Wedge with the granular fertilizer did not enhance the quality of the turfgrass and when applied alone very poor turfgrass quality was observed.

Total N Uptake. All tissue was collected and analyzed for total N content. Total N uptake was then calculated based on the tissue dry mass and the tissue N content. The total quantity of N taken up in response to applied treatments is presented in figure 32. As has been observed in the previous studies the pattern of N uptake followed the rate of applied N with the largest quantity of N being accumulated in response to the 100% recommended rate of N application. Inclusion of Wedge in the granular fertilizer did not appear to enhance the uptake of N by the St. Augustine.

FIGURE 32.

EFFECT OF N SOURCE ON ST. AUGUSTINE TOTAL N UPTAKE



Total P Uptake. Total P uptake followed basically the same trend as was observed for N uptake. As the rate of P application declined so did the total quantity of P taken up. Essentially the same statistical grouping as was observed for the N uptake was observed for the P uptake. Phosphorus uptake values for the treatments were as follows: 362, 338, 338, 264 and 40 mg P for Naturize(100%), Naturize (75%+W), Naturize(100%+W), Naturize(50%+W) and Wedge Alone, respectively.

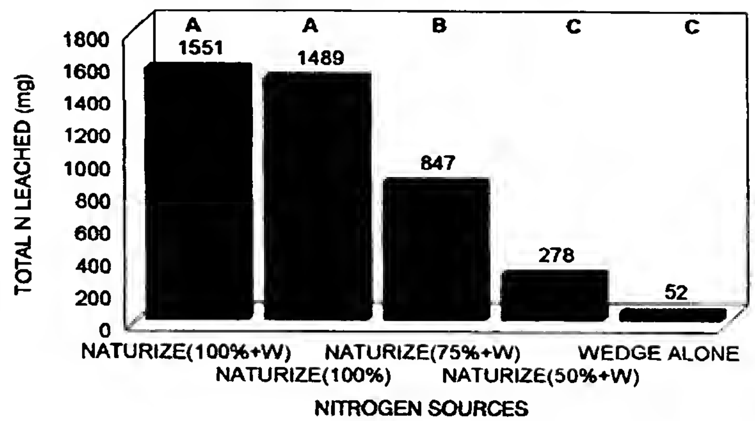
Total K Uptake. A similar treatment trend was observed for K uptake as was observed for N and K. Total K uptake levels according to applied treatment were as follows: 2.02, 1.98,

1.77, 1.34 and .21 g K for Naturize(100%), Naturize (100%+W), Naturize(75%+W), Naturize(50%+W) and Wedge Alone, respectively.

N Leached. In this study treatments were applied weekly and leachates were collected weekly; therefore, a lot more N leached from the system. Total N leached was calculated by summing all the leachate collections. Total quantity of N leached in response to applied treatments is presented in figure 33. The largest quantity of N leached from the experimental unit receiving the 100% recommended rate of N plus Wedge; however, it was statistically different from the 100% rate of granular fertilizer. But, this does suggest that the Wedge did not enhance uptake and reduce N leaching.

FIGURE 33.

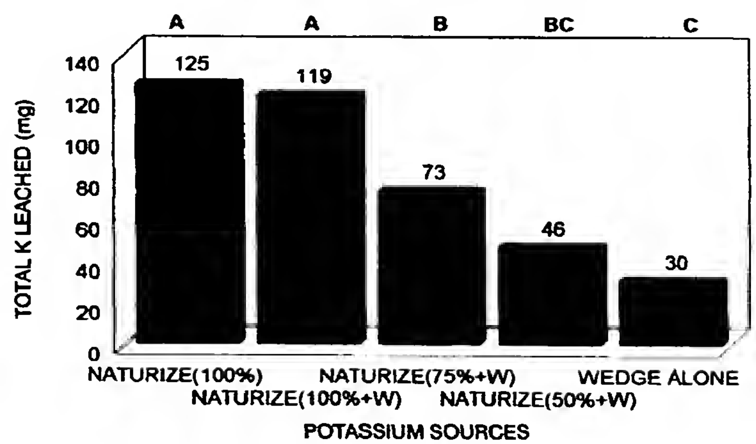
EFFECT OF N SOURCE ON TOTAL QUANTITY OF N LEACHED FROM ST. AUGUSTINE



K Leached. All leachates were also analyzed for K and the total quantity of K

FIGURE 34.

EFFECT OF K SOURCE ON TOTAL QUANTITY OF K LEACHED FROM ST. AUGUSTINE

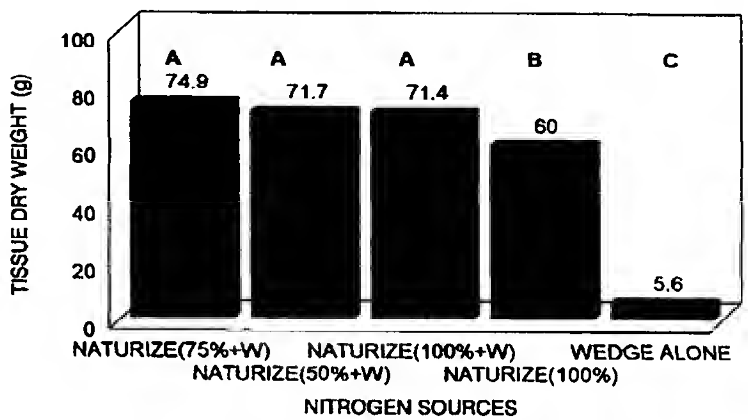


leached was calculated in the same manner. Smaller quantities of K leached than did N but the effect of treatment on quantity of K leached was essentially in the same order, except for a switching of the first two treatments. However, the differences in quantity of K leached from the first to treatments were not statistically different from one another. The total quantity of K leached as influenced by applied K source is presented in figure 34.

E. Grow-in Using Wedge Study: Bermuda Growth Rates. This study was set up the same as the previous study, except in this study Bermudagrass sprigs were used and the fertilizer was applied in liquid form. Tissue was collected through out the study period for total dry matter accumulation estimates. Total dry tissue values in figure 35 represent tissue only.

FIGURE 35.

EFFECT OF N SOURCE ON BERMUDA TISSUE DRY MASS



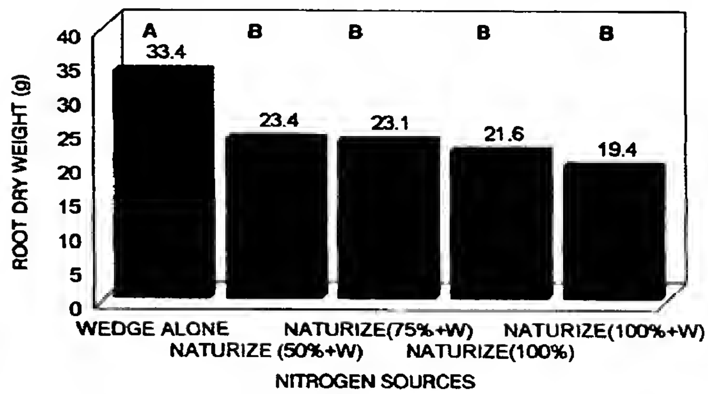
Treatment effects did not follow the N rate trend seen in previous studies. There does appear to be an effect of the Wedge addition on bermuda tissue dry weight since the treatment not receiving 100% the recommended N rate but not the Wedge produced statistically less dry matter than did the other treatments which received Wedge regardless of the N rate. It appears that when the Wedge is applied along with a liquid fertilizer source that there is an enhancement in tissue dry matter production as a result of the inclusion of the Wedge material.

Root Dry Weights. Roots were washed free of soil and dried for dry matter accumulation at termination of the study. The influence of treatments on root dry weight is presented in figure 36. A very interesting influence of treatment on root growth was observed. Bermudagrass produced more roots in the presence of Wedge alone than in response to treatments containing N.

Previous studies have indicated that increasing rates of N reduce the production of roots, but in those previous studies the response was generally related to a reduced rate of N and not a total elimination of applied N. As noted above the bermudagrass appears to respond to the application of Wedge along with the liquid fertilizer. It is difficult to drawn firm conclusions based on one study of this nature but it there was an approximate 30% increase in root dry production in response to the presence of Wedge alone.

FIGURE 36.

EFFECT OF N SOURCE ON BERMUDA ROOT DRY MASS

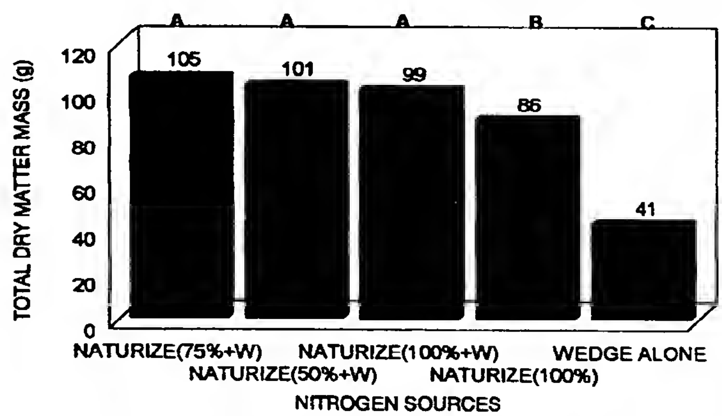


Verdure Dry Weights. Verdure dry weights were not significantly affected by applied treatments. Dry weights ranged from 7.94, 7.17,5.83, 4.78 to 1.64 for Naturize (100%+W), Naturize (75%+W), Naturize (50%+W), Naturize (100%) and Wedge Alone, respectively.

Total Dry Matter Accumulation. Total bermudagrass dry matter accumulation was calculated by summing the total tissue, verdure, and root dry weights. These combined values are shown in figure

FIGURE 37.

EFFECT OF N SOURCE ON BERMUDA TOTAL DRY MASS



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37. As was observed with the tissue dry mass it appears that of the Wedge product with the liquid Naturize product enhanced the total dry weight of bermudagrass because when Wedge was not used with the Naturize liquid (15-5-10) total dry matter mass was reduced.

N Uptake. A total of seven clippings collections were analyzed for total N content and the total N uptake was calculated using the total tissue clipping dry mass. The influence of applied treatment on total N uptake is presented in figure 38. Total N uptake was influenced by the presence of Wedge in the liquid fertilizer regardless of the level of N applied, except when no N was applied. When the tissue N concentration of the individual clippings collections are compared there was no consistent pattern relative to the influence of Wedge on tissue concentration; therefore, the Wedge influence on total N uptake must have been

FIGURE 38.

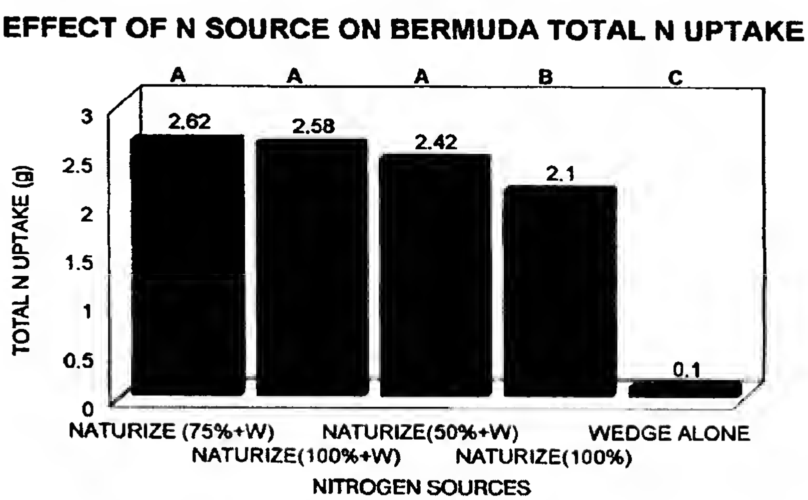
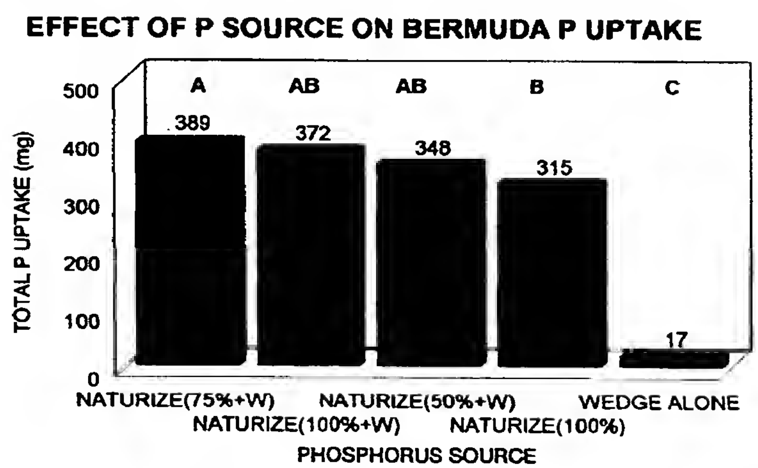


FIGURE 39.



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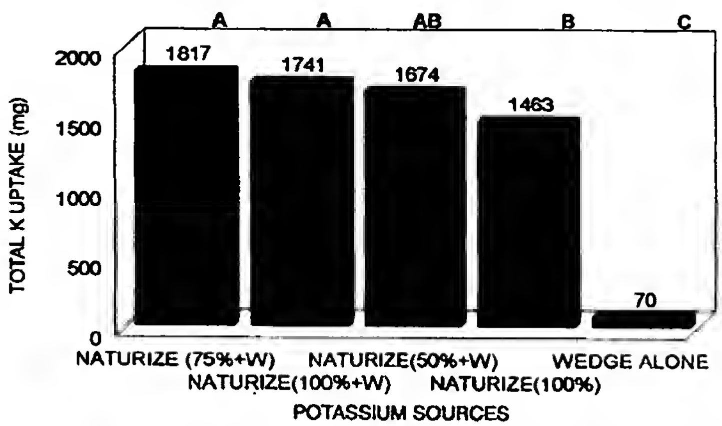
more related to its influence the dry matter accumulation than tissue N content.

P Uptake. Total P uptake was likewise enhanced by the presence of Wedge addition to the liquid fertilizer (Figure 39). Phosphorus concentration of the tissue of the individual clippings collections was not influenced by the inclusion of Wedge. It appears that only the dry mass of the tissue was enhanced by the Wedge addition.

FIGURE 40.

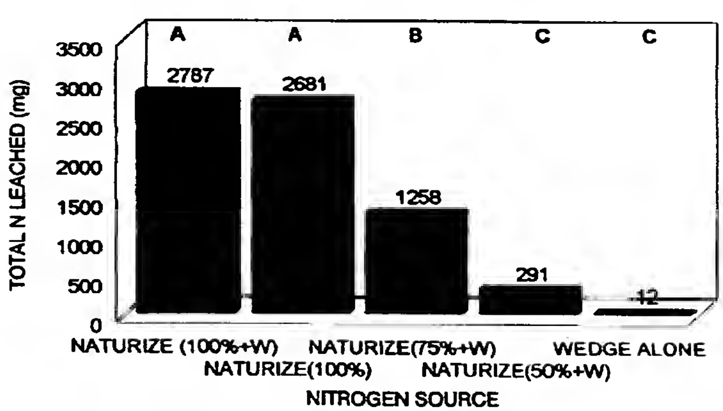
EFFECT OF K SOURCE ON BERMUDA TOTAL K UPTAKE



K Uptake. Total K uptake was influenced by the presence of Wedge (Figure 40). There was no consistent influence of the rate of applied K on total uptake or tissue concentration. A trend for a reduction in total K uptake exists in response to the application rate of K when Wedge was applied, but the exclusion of Wedge resulted in a significant reduction in total K accumulated by the tissue. This influence on total K uptake was most likely the result of its overall influence on dry matter mass.

FIGURE 41.

EFFECT OF N SOURCE ON TOTAL QUANTITY N LEACHED



N Leached. Leaching quantities of water applied weekly as well as the liquid fertilizer treatments. The quantity of N leached each week

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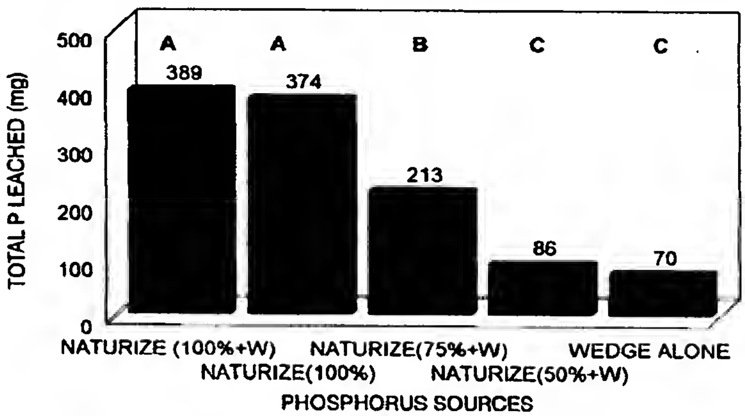
was small in magnitude initially and increased on a weekly basis in response to the added treatments. The total quantity of N leached followed the rates of applied N. Inclusion of Wedge with the liquid fertilizer N source did not reduce the total quantity of leached N (Figure 41).

P Leached. Total P leached also followed the rate of application. Only about 15% as much P leached as total N leached, but only about 15% as much P was applied in the liquid fertilizer as N. There was no apparent influence of including Wedge in the liquid fertilizer on the quantity of P leached (figure 42).

FIGURE 42.

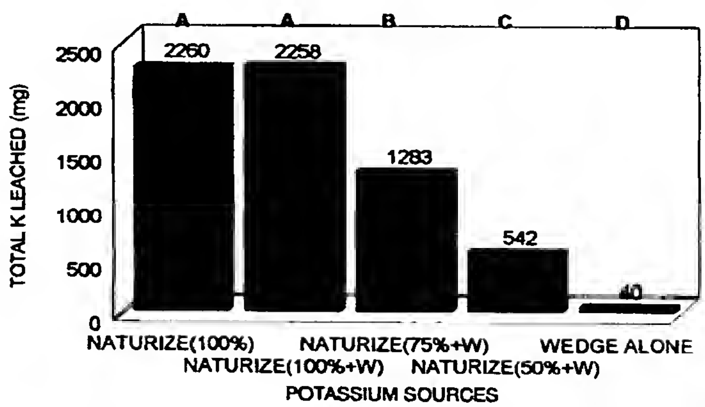
EFFECT OF P SOURCE ON TOTAL QUANTITY OF P LEACHED



K Leached. About 25% less total K leached than N, but the same trend relative to rate of applied nutrients exists. The higher the rate of applied K the more K leached, but influence on reducing K leaching by the inclusion of the Wedge was observed. (Figure 43).

FIGURE 43.

EFFECT OF K SOURCE ON TOTALQUANTITY OF K LEACHED



CONCLUSIONS:

In the field study, Turfbuilder produced the most total growth. Applying the Naturize (15-4-7) product at 100 and

75% of the recommended rate produced less total growth, but maintained quality at an acceptable level. A reduced and unacceptable level of growth was observed when the Naturize product was applied at 50% of the recommended rate. Total N and K uptake were excellent for the Naturize products applied at the 100 and 75% of the recommended rate, but P uptake was somewhat reduced compared to the other commercial sources used in the study.

In the glasshouse study comparing the commercially available products with Naturize 15-4-7 the Naturize, Lesco and Turfbuilder products produced the most growth and highest quality turfgrass when applied at 100% of the recommended rate. The largest quantity of root growth was produced by the Naturize products applied at 100 and 75% of the recommended rate while the Turfbuilder product produced the least root biomass. Application of the Naturize product at 100% of the recommended rate resulted in superior uptake of N, P and K. This study confirmed the current guidelines of applying no more than 1.0 lbs of N/1000 sq ft/30 day in order to limit the environmental impact of turfgrass fertilization in that no detectable levels of N were observed during the entire study period. Very low levels of P and K were detected in the leachates as well.

In both the studies involving the application of granular and liquid Naturize fertilizers on sodded bermudagrass the predominant effect on growth, quality, uptake and leaching was related to the rate of fertilizer applied. There was no detectable effect related to the inclusion of Wedge in the fertilizer.

During the grow-in study St. Augustine grass growth, quality, nutrient uptake and leaching losses were related to the rate of fertilizer applied in granular form. There was no statistical advantage in applying the Wedge product, but on an absolute magnitude basis the fertilizers receiving Wedge produced more growth.

During the grow-in of the bermudagrass a different picture emerged. In every growth measurement, foliar tissue, roots, verdure and total growth, inclusion of the Wedge product with any of the rates of the liquid Naturize product statistically increased growth. Likewise N, P and K uptake were improved by the inclusion of the Wedge product. However, inclusion of the Wedge product did not reduce the leaching of N, P, and K. The weekly applications of relatively high rates of fertilization may have been the reason for the lack of Wedge influence on leaching losses.

In summary, it does appear that the granular Naturize (15-4-7) product is capable of

producing quality turfgrass growth and superior uptake of N and K when applied at 100 and 75% of the recommended rate compared to other commercially available turfgrass fertilizers without producing excessive growth or N leaching losses.

No statistical advantage in turfgrass growth, quality, nutrient uptake, or leaching losses was noted relative to the inclusion of Wedge with either the granular or liquid Naturize product. However, bermudagrass growth, quality, and nutrient uptake were improved when the turfgrass was sprigged and Wedge was applied during grow-in. This finding needs to be further investigated and reconfirmed.

Appendix VI.

Evaluating Effects of a Biological Fertilizer on Tomato Growth in South Florida (2003)

Research Report

July 16, 2003

Evaluating Effects of a Biological Fertilizer (NA2101A) on Tomato Growth in South Florida

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Tropical Research and Education Center
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Objective:

To evaluate effects of a biological fertilizer (NA2101A) on soil fertility, leaf nutrition, plant growth and yield of tomatoes grown on a calcareous soil in south Florida.

Materials and Methods:

The experiment included three treatments: 1) Grower fertilizer rate 100% (Standard practicc); 2) Grower fertilizer rate 100% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip); and 3) Grower fertilizer rate 75% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip). All treatments were replicated 4 times.

The trial was conducted at the research farm, Tropical Research and Education Center, University of Florida, on a Krome very gravelly loam soil. A typical polyethylene covered raised-bed was 36 in wide, 6 inch high and 72 inches apart. Fertilizer was applied on Nov. 28, 2002 at the rate of 100 lb N/ac using fertilizer 6N-6P205+12K20 for treatments 1 and 2 and the rate of 50 lb N/ac as a liquid fertilizer (4N-0P2O5-8K2O) injected weekly through irrigation system from Jan. 20, 2003 to March 28, 2003.

'Sanibel' tomato plants were transplanted in a single row in the center of each bed with 20 inches between plants on Dec. 6, 2002. NA2101A was applied as starter fertilizer during transplanting at the rate of 2 qt/ac and same amount of NA2101A was injected through irrigation system on Dec. 23. Soil and leaf samples were collected on March 4, 2003 and were analyzed for P, K, Ca, Mg, Zn, Mn, Cu and Fe.

Tomatoes were harvested two times on March 13 and March 31, 2003. Total number, total weight and color of fruit from each plot were recorded.

Results:

1. Total marketable yield, large fruits, early yields (red fruits and marketable fruits) and culls were not significantly affected by three treatments (Table 1).

2. We measured greenness of tomato leaves through the growing season. Tomato leaves were significantly greener (higher SPAD reading) from plants received treatment 2 (grower fertilizer rate 100% + NA2101A) than these plants from treatment 3 (grower fertilizer rate 75% + NA2101A). There was no significant difference among treatments during the late growing season (Table 2).

3. Plant available nutrients in soils collected during tomato growing season were not significantly affected by treatments except soil K. Concentration of soil K was increased 3 times with application of NA2101A biological fertilizer compared to control, which received same amounts of regular fertilizers (Table 3).

4. Concentrations of nutrients in plant tissue samples collected during flowering stage were statistically same among treatments (Table 4).

Summary:

1. The experiment results were preliminary because of only one growing season trial and few treatments. Long-term experiments with various locations are needed to thoroughly evaluate the biological fertilizer.

2. NA2101A application affected leaf color during early season. However, its effect did not last very long. Increasing application frequency during the growing season may improve the performance of NA2101A.

3. High concentration of soil K in treatment 2 indicates possible effect of NA2101A on plant available K. The high soil K was also possibly induced by sampling variation or other experimental error. Further study is necessary to make solid conclusion.

4. Treatment 3 should perform better in a commercial farm, which usually have high residue nutrients from previous crops.

Table 1. Effects of NA 2101A treatments on tomato fruit yield.

Treatment†	Early yield Red	Early yield Marketable	Extra large	Total Marketable	Cull
	----------------------------	----------------------------	cartons/acre	----------------------------	----------------------------
1	353a*	599a	583a	1893a	99a
2	241a	467a	581a	1790a	86a
3	280a	560a	443a	1765a	118a

* Means followed by the same letter are not significantly different by Duncan's multiple range test, 5% level.

†Treatment 1- Grower fertilizer rate 100% (Standard practice); Treatment 2- Grower fertilizer rate 100% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip); and Treatment 3- Grower fertilizer rate 75% + NA2101A (2 qt/ac in transplant water and 2 qt/ac at 14 days through drip)

Table 2. Effects of NA2101A treatments on leaf greenness measured with a chlorophyll meter (Minolta 502). The higher SPAD reading indicates the greener of the leaf.

Treatment†	Days after transplanting 14	28	42	88
	----------------------------	SPAD readings	----------------------------	----------------------------
1	46.9ab*	54.9a	57.9a	57.3a
2	47.9a	53.3a	56.7a	57.4a
3	44.6b	53.6a	56.0a	57.3a

* Means followed by the same letter are not significantly different by Duncan's multiple range test, 5% level.

†Treatment 1- Grower fertilizer rate 100% (Standard practice); Treatment 2- Grower fertilizer rate 100% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip); and Treatment 3- Grower fertilizer rate 75% + NA2101A (2 qt/ac in transplant water and 2 qt/ac at 14 days through drip)

Table 3. Effects of NA 2101A treatments on plant available nutrients in soils collected 88 days after transplanting.

Treatment†	P	K	Ca	Mg	Zn	Mn	Cu	Fe
	mg/kg							
1	36a	81b	309a	28a	12a	5a	40a	34a
2	41a	264a	321a	49a	14a	5a	41a	35a
3	39a	53b	307a	25a	14a	5a	42a	36a

* Means followed by the same letter are not significantly different by Duncan's multiple range test, 5% level.

†Treatment 1- Grower fertilizer rate 100% (Standard practice); Treatment 2- Grower fertilizer rate 100% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip); and Treatment 3- Grower fertilizer rate 75% + NA2101A (2 qt/ac in transplant water and 2 qt/ac at 14 days through drip)

Table 4. Effects of NA 2101 treatments on plant tissue samples collected 88 days after transplanting.

Treatment†	P	K	Ca	Mg	Zn	Mn	Cu	Fe
	%				mg/kg			
1	0.225a*	2.00a	3.31a	0.47a	27.3a	122a	41a	91a
2	0.225a	1.94a	3.37a	0.47a	26.8a	126a	42a	87a
3	0.218a	1.65a	3.58a	0.46a	23.3a	134a	43a	95a

* Means followed by the same letter are not significantly different by Duncan's multiple range test, 5% level.

†Treatment 1- Grower fertilizer rate 100% (Standard practice); Treatment 2- Grower fertilizer rate 100% + NA2101A (2qt/ac in transplant water and 2 qt/ac at 14 days through drip); and Treatment 3- Grower fertilizer rate 75% + NA2101A (2 qt/ac in transplant water and 2 qt/ac at 14 days through drip)

Appendix VII.

The Effect of Naturize Microbial Amendment on St. Augustine Grass Quality and Growth in South Florida (2003)

2002 NATURIZE BIOSCIENCES, INC. PROJECT

THE EFFECT OF NATURIZE MICROBIAL AMENDMENT (NA2102) ON ST. AUGUSTINEGRASS QUALITY AND GROWTH IN SOUTH FLORIDA

FINAL REPORT
February 12, 2003

PRINCIPAL INVESTIGATOR: John L. Cisar

LOCATION: University of Florida, Fort Lauderdale Rescarch and Education Center, Fort Lauderdale, FL 33314

OBJECTIVE: To determine the efficacy of Naturize's NA2102 alone and in combination with fertilizer when applied to St. Augustinegrass.

TREATMENTS:

1. NA2102 @ 4qts/A + 4qts/A @ 14days
2. NA2102 @ 4qts/A + 2qts/A @ 14days & 28days
3. NA2102 @ 2qts/A + 2qts/A @ 14days, 28days, & 42days
4. NA2102 @ 4qts/A + 2qts/A @ 14days with 0.75 lbN/1000ft^2 16-4-8
5. NA2102 @ 4qts/A + 2qts/A @ 14days with 0.50 lbN/1000ft^2 16-4-8
6. 1.0 lbN/1000ft^2 16-4-8 only

MATERIALS AND METHODS:

On September 27, 2002 the above treatments were initiated on 'Floratam' St. Augustinegrass. Treatments were randomized within 6 replications of 1m X 2m plots. Treatments were re-applied according to the schedule above on 11 October, 25 October, and 8 November. Before re-application, plots were rated for quality and color (scale of 1-10 with 10=dark green turf, 1=dead/brown turf, and 6=minimally acceptable turf) and clipping samples were collected at a mowing height of 3.0inches. Ratings and clippings samples were taken throughout the experimental period. On December 1, 2002 soil cores were taken to an 8inch depth with a 4-inch diameter cup cutter to determine root mass. All data was subject to statistical analysis and significant means were determined.

RESULTS:

Significant differences were observed on most rating dates for turfgrass visual quality and color (Tables 1 and 2). Treatments 4 and 6 tended to have the highest ratings for quality and color while Treatment 1 had among the lowest ratings on most dates (Tables 1 and 2). Treatments 4 and 6 impact on turfgrass quality was longer than Treatments 1-3 (Tables 1 and 2). Clipping weight differences were observed and followed the pattern of the quality and color ratings (Table 3). Treatment 4 had the highest numeric average dry clipping weight (Table 3). Root mass was unaffected by treatment (Table 4).

Table 1. Turfgrass quality ratings for Naturize Biosciences fertilizer test initiated on September 27, 2002 at the Fort Lauderdale Research and Education Center.

Source	10/2	10/10	10/25	11/1	11/8	12/04	12/16
TRT 1	6.7b	7.8bc	7.4c	5.9d	6.5b	7.3c	7.1
TRT 2	6.8b	8.0abc	7.8bc	6.8bc	6.9ab	7.3c	7.3
TRT 3	6.7b	8.2abc	7.8bc	6.3cd	6.6b	7.1c	7.2
TRT 4	7.9a	8.5ab	8.4ab	7.3ab	7.2ab	7.8ab	7.3
TRT 5	7.6a	7.5c	7.9bc	7.1ab	7.2ab	7.4bc	7.3
TRT 6	8.2a	8.7a	8.8a	7.6a	7.6a	8.0a	7.1
Signif.	**	*	**	**	+	**	ns

**, *, + and ns = P<0.01, P<0.05, P<0.10 and P>0.10 respectively.

Turfgrass quality ratings based on 1-10 scale with 10=dark green turf, 1=dead/brown turf, and 6=minimally acceptable turf.

Means with the same letter within a column are not significantly different according to Duncan's Multiplc Range Test.

Table 2. Turfgrass color ratings for Naturize Biosciences fertilizer test initiated on September 27, 2002 at the Fort Lauderdale Research and Education Center.

Source	10/2	10/10	10/25	11/1	11/8	12/04	12/16
TRT 1	7.1bc	8.3	7.5c	6.1b	6.8c	7.4b	7.5
TRT 2	7.3b	8.3	8.2b	7.3a	6.8c	7.5b	7.8
TRT 3	6.4c	7.7	8.0bc	6.8ab	6.8c	7.3b	7.5
TRT 4	8.7a	8.3	8.5b	7.3a	7.6ab	8.2a	7.6
TRT 5	7.8b	7.8	8.3b	7.3a	7.4b	7.6b	7.8
TRT 6	8.7a	8.4	9.1a	7.7a	7.8a	8.4a	7.4
Signif.	**	ns	**	**	*	**	ns

**, ns, and * = P<0.01, P>0.10, and P<0.05 respectively.

Turfgrass color ratings based on a 1-10 scale with 10=dark green turf, 1=dead/brown turf, and 6=minimally acceptable turf.

Means with the same letter within a column are not significantly different according to Duncan's Multiple Range Test.

Table 3. Turfgrass clipping dry weights (grams) for Naturize Bioscicncc's fcrtilizer test initiated on September 27, 2002 at the Fort Lauderdale Research and Education Center.

Source	10/2	10/25	11/8	12/16
TRT 1	90.7	39.2bc	5.2bc	28.9
TRT 2	83.4	30.0d	3.4c	22.1
TRT 3	77.0	29.6d	4.2c	20.1
TRT 4	88.5	48.4a	8.2a	28.5
TRT 5	86.1	37.4cd	5.3bc	27.7
TRT 6	92.0	46.6ab	6.8ab	28.2
Significance	ns	**	**	ns

ns and ** = P>0.10 and P<0.01

Means with the same letter within a column are not significantly different according to Duncan's Multiple Range Test.

Table 4. Root dry weights (grams) for Naturize Bioscience's fertilizer test soil cores taken post-treatment on December 16, 2002.

Source	Post-treatment root mass (grams)
TRT 1	2.9
TRT 2	3.3
TRT 3	1.6
TRT 4	2.8
TRT 5	2.3
TRT 6	2.4
Significance	ns

ns = $P>0.10$

Appendix VIII.

Alternative Nitrogen Sources for Corn (2003)

ALTERNATIVE NITROGEN SOURCES FOR CORN

Cooperative study: The Andersons, Inc.; Pursell Industries, Inc.; Naturize BioSciences, Inc.; and The Ohio State University

Objective: to evaluate experimental controlled-release N as a N source for corn production

Project leader: E. M. Lentz

Location: Northwestern Branch of the Ohio Agricultural Research and Development Center, Custar, OH

FIELD BACKGROUND

Planting Date: April 30, 2003

Harvest Date: October 24, 2003

Hybrid: Select Seed Bt 902, at 30,000 seeds/acre

Soil: Hoytville clay with systemic tile drainage

Soil test values: P = 45 ppm; K = 177 ppm; pH = 6.3

Previous crop: wheat

Tillage method: plowed, disked and land leveled twice fall 2002
Fertilizer surface applied and incorporated with field cultivator just before planting

Plot Dimensions: 10 x 80 feet consisting of four rows, 30 inches apart.

METHODS

Experimental Design: two factor completely randomized block replicated four times.

Fertilizer Treatments: three N rates (120, 160, 200 lb/a) of urea, Exp N, ESN (formerly called Duration), urea + Naturize's All Purpose Plant Bio-Nutrition Formula (APPBNF), Exp N + APPBNF and a zero N rate.

Statistical analysis: ANOVA, 3x5 factorial

Nitrogen fertilizer application: surface applied with a Gandy spreader and incorporated with a field cultivator prior to planting.

Ear-leaf Analysis: ten ear leaves were collected for plant analysis at growth stage R1. Analysis was completed by Spectrum Analytic, Inc. (Washington Courthouse, OH).

Harvest populations: estimated by counting the number of plants in a 17.4 feet of each harvest row. The center two rows were harvested to estimate grain yield and moisture.

RESULTS

Relatively warm and dry fields conditions allowed an earlier than normal planting date (Table 1). The crop was two to three weeks behind normal because of an above average rainfall in early May followed by cooler than normal temperatures in late May and early June. Above normal rainfall in July and August with moderate temperatures produced a larger than normal corn crop.

Significant differences occurred among N sources and among N rates for grain yield (Table 2). There were no significant interactions between N source and N rate, so differences were similar among N sources regardless of N rate. Means were similar among treatments for grain moisture, harvest population and N uptake.

All plots responded to N with an 80.4% increase in yield for the N treatment means compared to the zero check (Table 3). Excluding the zero check, yields ranged between 205.2 to 253.3 bu/A with an average yield of 232.0 bu/A. Yields increased with increased N to the 160 lb/A rate. Yields were similar between the 160 and 200 lb N treatments. The greater N rates increased yields 4.1% compared to 120 lb N rate.

Only one treatment yielded significantly more than urea (Table 3). Urea blended with APPBNF increased yield 3.2% compared to urea alone. All other treatments had similar yields to urea. Exp N treatments yielded significantly less than the urea plus APPBNF and ESN treatments, 4.3% and 3.8% respectively. Urea plus APPBNF and ESN treatments had similar yields.

All N treatments contained significantly more tissue N than the zero check (Table 1). Uptake was similar among N rates and N sources. Excluding the zero check, the overall N uptake mean was 2.97%. The range was 2.16 to 3.48%.

Statistical differences were not detected among any treatment for grain moisture or harvest population (Table 3). Excluding the zero check, the overall means for grain moisture and harvest population were 17.1% and 27,750 plants/A, respectively. Grain moisture range was 14.2 to 19.3% and for the harvest population, 25,000 to 30,500. In some plots a few plants had snapped below the ear and evidence of moderate root lodging from a strong wind that occurred in July. These plants were included in the harvest population. Plants with more severe root lodging had recovered enough by the end of the season (goosenecked) that harvest was not a problem. There was no relationship between N source and number of plants affected. Plot damage was < 1%.

DISCUSSION

Crop was planted relatively early and emerged uniformly. Soil moisture was not limited any time during the growing season. These two events were major factors that led to above normal yields. Regular showers throughout the season may have caused roots to be less deep than some years and also kept development of new roots (root hairs, the part most active in nutrient uptake) nearer the surface. Otherwise, conditions would be considered normal for a high yield environment in the area.

Exp N treatments were the lowest yielding treatments in the study and provided yields no better than the urea check. Even though not significant, N uptake was the lowest for these treatments as well. Nitrogen uptake levels were in the low end of the sufficiency range for all treatments. Some plots may have already started to pull N from the ear leaf since collection was delayed until the zero check reached Growth Stage R1 causing a lower tissue value. Adding APPBNF did not increase yields for the Exp N product. Since I am not privy to the release mechanism in Exp N, I cannot discuss how its activity may have been affected in this field.

Adding APPBNF to urea increased yields over the urea check. Since the N uptakes at GS R1 were similar between the two treatments, improved uptake would not account for the difference. However, uptake may have been different at other critical times such as early or late developmental stages. ESN had similar yields as urea plus APPBNF, so possibly the rate or form of N available to the crop may have accounted for some of the yield benefit. Note that the ESN treatment was not significantly larger in yield than urea at the 5% level, but would have been at the 10% level. The 120 lb N ESN and urea plus APPBNF treatments appeared to be as effective as urea at the 160 lb N rate; regardless, when examining these products alone, yields increased at the 160 lb N rate.

CONCLUSIONS

In a high yield environment:

1. Exp N had no advantage in yield or other agronomic characteristics when compared to urea.
2. The potential uses and mechanism of APPBNF should be furthered explored as a possible yield enhancer for urea.

Table 1. Temperature and rainfall averages for 2003 season and 30 year average (normal), Northwestern Branch, Ohio Agricultural and Research Development Center, Custar, Ohio.

Date	Temperature		Rainfall	
	Season	Normal	Season	Normal
	----?F----		----inches----	
March	37.9	36.7	2.21	2.51
April	49.1	48.9	3.47	3.25
May 1-15	57.2	56.9	5.28	1.47
16-31	58.0	62.6	1.05	1.97
June 1-15	63.5	67.8	1.37	1.91
16-30	69.5	71.2	2.86	1.63
July	70.9	72.8	5.25	3.79
August	71.1	70.6	4.43	2.97
September	57.5	64.0	4.07	2.71
October	50.6	52.5	1.80	2.34
Total	---	---	31.79	24.55

Table 2. Analysis of Variance for Fertilizer Source and N

	Yield	Grain Moisture	Harvest Stand	Nitrogen Uptake
Fertilizer Source	??	ns	ns	ns
Nitrogen Rate	??	ns	ns	ns
Source x Rate	ns	ns	ns	ns

??Significant at the 0.01 level.

Table 3. Grain yield and moisture, harvest population and N uptake response to N rate and N source for corn

N Source	N Rate (lb/A)				Source
	0	120	160	200	Mean
Grain Yield			*bu/A*		
Check	128.5				
Urea + APPBNF†		228.0	240.9	243.9	237.6 a
ESN		231.2	238.8	239.1	236.3 ab
Urea		223.9	230.3	237.4	230.3 bc
Exp N +APPBNF		225.0	229.5	234.1	229.5 c
Exp N		219.9	227.9	230.2	226.0 c
Rate means		225.6	233.5	236.9	
Lsd (0.05)					6.3
Grain Moisture			%		
Check	14.9				
Urea + APPBNF		17.2	16.8	17.3	17.1
ESN		17.0	17.3	17.5	17.3
Urea		16.6	17.2	17.5	17.1
Exp N +APPBNF		16.1	16.7	17.1	16.6
Exp N		17.3	17.6	17.8	17.6
Rate means		16.8	17.1	17.5	
Lsd (0.05)					ns
Harvest Population			*plants/A*		
Check	29000				
Urea + APPBNF		27375	27125	28000	27500
ESN		27375	28500	27500	27792
Urea		28125	27500	28500	28042
Exp N +APPBNF		27500	28500	27000	27667
Exp N		28250	27125	27875	27750
Rate means		27725	27750	27775	
Lsd (0.05)					ns
N uptake			%		
Check	1.65				
Urea + APPBNF		2.94	3.10	2.98	3.01
ESN		3.15	3.05	3.10	3.10
Urea		2.91	3.08	3.14	3.04
Exp N +APPBNF		2.83	2.86	2.94	2.88
Exp N		2.88	2.69	2.94	2.83
Rate means		2.94	2.95	3.02	
Lsd (0.05)					ns

†APPBNF = Naturize's All Purpose Plant Bio-Nutrition Formula

Appendix IX.

Evaluating the Effect of Naturize on Field Corn Development and Yield at Full and Half Fertilizer Rates (2001)

NATURIZE™ BIOSCIENCES

2001 PRECISION CONCEPT RESEARCH

Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates

AGRI-GROWTH®
Communicating leading technology to a changing industry
2001 C-02

INTRODUCTION

Precision Concept Research is research in actual commercial field situations. It takes up where traditional small plot research leaves off by incorporating field-sized variability of real growing conditions. Today's growers want hard proof that a product, service or management option has been tested under field conditions similar to their own. The strength of precision concept research is that it provides results to growers that are calculated into returns on investment, which pertain to their bottom line.

This booklet records the results of precision concept research undertaken by Agri-Growth, Inc., for AgriEnergy Resources during the 2001-growing season. The research involved a study **(Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates)** that looked at Naturize™ for field corn.

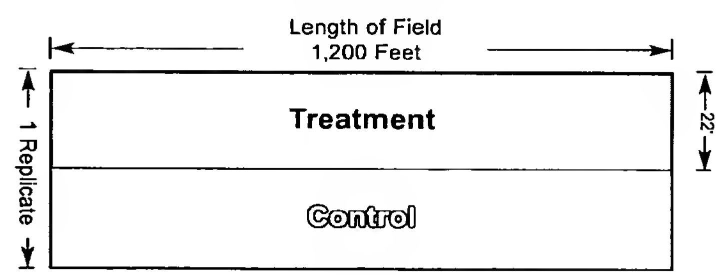
Agri-Growth, Inc.

Agri-Growth® is an independent third party supplier of applied research and education to the food and fiber industry. For 22 years we have been converting information and new technologies into applied knowledge, enabling growers to maximize profits while managing risk. Agri-Growth is a forerunner in precision concept research. Our experts in Geographic Information Systems (GIS) design research studies using precision farming components: Global Positioning System, variable rate applications, geostatistics, aerial imaging and yield monitors.

PRECISION CONCEPT RESEARCH

The main advantage of doing precision concept research is that it allows an evaluation of product performance based on real stress factors in crop growth and development. Traditional small plot or laboratory research data gathered under ideal growing conditions is less relevant to growers who deal with weather, pest, and soil variability on a daily basis. By looking at the performance of inputs or agronomic practices and services within natural cropping situations, evaluations can be based on the product's ability to compensate for stress factors to improve crop growth and development.

Protocols Agri-Growth has developed for conducting research require the use of field-sized plots ranging from 15 to 80 acres in size and the use of a combine with GPS and a yield monitor. In designing research studies, Agri-Growth alternates treatment and check strips that match planter and combine width. This protocol is easily adapted for testing many different products, rates, planting populations, and tillage practices. The more strips that are placed in the field the better the study will be.

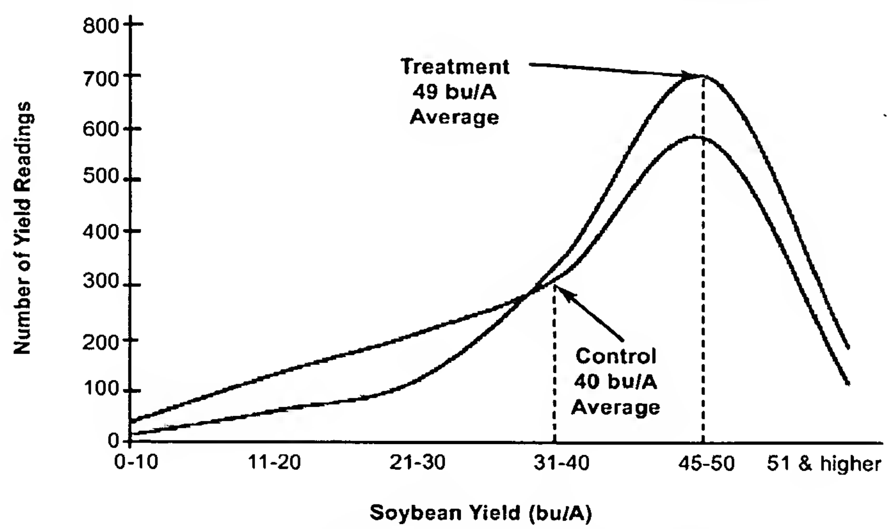


Strip layout.

At harvest each treatment strip is entered as a different load in the yield monitor. Like other precision instruments, yield monitors sometimes generate "far-out" data—on the average, about five out of every 8,000 readings will be obvious errors. Agri-Growth uses computer algorithms to smooth data and eliminate outlying readings. Following these protocols eliminates the potential for bias to influence results, and performance data is generated under the same conditions that farmers contend with every day.

Once the data is smoothed and outlying readings eliminated, results are plotted based on number of monitor readings and yield. In this way, yield monitor data is made easily decipherable into graphed curves that separate treatment(s) from control. The figure below is an example of how yield readings are developed into smooth curves. In nearly all cases when there is a marked difference between treatment and control readings, graphed curves will offset one another, with lower yield readings and frequency of occurrence appearing to the left of the treatment curve. When positive effects from treatments are achieved, readings of treated strips will also appear in a narrower band than control strips. This is because treatments have a uniforming effect on reducing stress to plants, allowing them to better utilize their genetic yield potential

The figure below gives an example of a yield monitor reading comparisons for product study.



Yield monitor reading comparisons for product study.

Agri-Growth's concept research also provides an interpretation of Return on Investment (ROI). ROI is a calculation of the actual dollars earned from yield gain or loss due to the use of products, services, farming practices, etc.

CONCLUSION: CORN YIELD UP 23% USING HALF RATE OF STARTER FERTILIZER

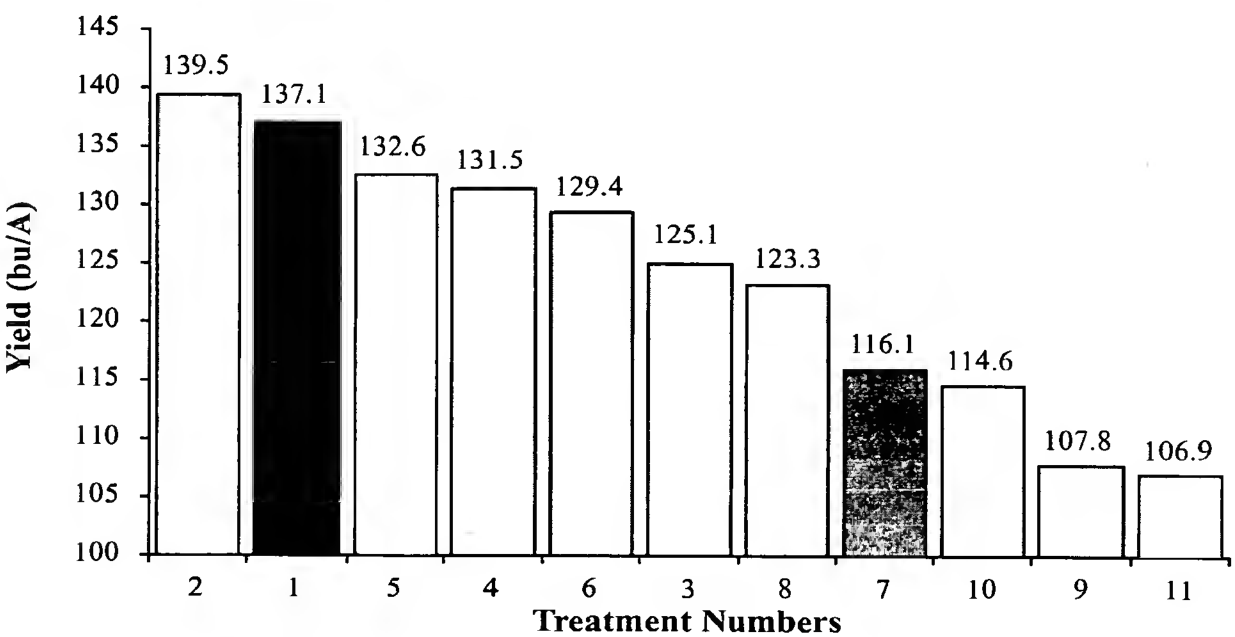
Naturize at full starter fertilizer rates increased corn yields 29%, or 31 bushels per acre, compared to control at full starter fertilizer rates.

Naturize (Treatment 1 & 2) versus control (Treatment 11), using full starter fertilizer rates, increased yields to 138.3 bu/A from 106.9 bu/A, an average increase of 31.4 bu/A or 29%.

Naturize at half starter fertilizer rates increased corn yields by 23%, or 25 bushels per acre, compared to control at full starter fertilizer rates.

Naturize (Treatment 5 & 6), at half starter fertilizer rates, versus control(Treatment 11), at full starter fertilizer rates, increased yields to 132 bu/A from 106.9 bu/A, an average increase of 25 bu/A or 23%.

Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates



Evaluating the Effect of Naturize™ on Field Corn Development and Yield with Full and Half Fertilizer Rates

Research Results

This study evaluates the products' ability to influence yield response. A 80 acre field was planted with field corn hybrid Heartland HX 1078 on June 11, 2001 (32,000 SPA) in 22 foot wide strips 1,000 feet long. Treated strips were alternated with control strips in five replicates and comparisons tracked throughout the season and harvest. The average soil texture in these strips is loamy with an average CEC of 12.3 and average pH of 6.7.

Growing Season

Normal Planting Date and Below-Normal Heat Unit Accumulations – GDU accumulations were below normal through June, with normal GDU and excellent field drying conditions at the end of the season.

High Early Season Rainfall – After planting, rainfall in May and June was above normal, resulting in crop stress following emergence.

Stand Establishment and Crop Maturity – Extremely dry soil moisture levels after mid-June due to ~ one rain event per month until crop maturity.

Yield Results

The yield map (page 7) of this study is a valuable tool to show the yield variances that occurred. However, the map by itself is difficult to interpret. For example, one does not see strips of light blue for the Naturize™ treated areas and strips of red for control areas. Mapping software assigns a range of colors for yield levels and there may be no pattern related to the treatments. A more precise method to analyze the data is to use math and graph the results.

The line graph shows how the yield monitor data in the map can be graphed into easier to understand smooth curves (page 8). The data shows that the average yield for Naturize™ (green) treatment was 139.5 bu/A, the midpoint average within the Naturize™ monitor readings inside the green curve. The average for Control (red) shifts to the left where the midpoint average is 106.9 bu/A, based on all of the monitor readings within the red curve.

The Bottom Line

The bar chart shows the bushel per acre yield advantage (page 9), a grower may likely see if he decides an application of Naturize™ is appropriate under field conditions similar to those in the study.

Statistics

The Duncan's multiple range test (DMRT) as shown on the last page (page 10), is used to determine if significant differences have occurred between treatments. This test indicates statistical separation between the twelve treatments as follows: 139.5 bu/A (a), 137.1 bu/A (a), 132.6 bu/A (b), 131.5 bu/A (b), 129.4 bu/A (b), 125.1 bu/A (c), 123.3 bu/A (c), 116.1 bu/A (d), 114.6 bu/A (d), 107.8 bu/A (e) and 106.9 bu/A (e).

DUNCAN'S MULTIPLE RANGE TEST (DMRT)

A statistical evaluation of the studies was conducted using the Duncan's Multiple Range Test (DMRT). The DMRT allows you to evaluate statistical differences between treatments and the probability that those differences are real and not due to chance. The ninety-five percent level of confidence was used. If treatments are significantly different, they will be followed by different letters (a, b, c). This means that ninety-five percent of the time, under similar parameters, these differences among treatments should occur.

Soil Analysis Test Site[1]

Organic Matter (%)	Phosphorous (ppm)		Potassium (ppm)	Magnesium (ppm)	Calcium (ppm)	Soil pH
	P_1	P_2				
3.4	28	53	279	173	1,612	6.7

Buffer Index (pH)	CEC (meg/100 g)	%K	%Mg	%Ca	%H
---	12.3	13.6	17.2	69.1	0

[1]The soil analysis report is an average of 32— 2.5 acre grid samples.

Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates – 2001

Project Code: C-02 | Location: Hollandale, MN

Sponsor: Naturize™ BioSciences | By: Agri-Growth, Inc.

Site Layout

Length of Field – 1,000 Feet

22'

1 Replicate

1. A + C — IFT (30 oz/A + 30 oz/A) (FSFR)
2. A + C — IFT (15 oz/A + 15 oz/A) (FSFR)
   + A + C — SD (15 oz/A + 15 oz/A)
3. B + C — IFT (30 oz/A + 30 oz/A) (FSFR)
4. B + C — IFT (15 oz/A + 15 oz/A) (FSFR)
   + B + C — SD (15 oz/A + 15 oz/A)
5. B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A)) (HSFR)
6. B + C — IFT (15 oz/A + 15 oz/A + 30 oz/A) (HSFR)
   + B + C — SD (15 oz/A + 15 oz/A)
7. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A) (FSFR)
8. A + B + C — IFT (15 oz/A + 15 oz/A + 15 oz/A) (FSFR)
   + A + B + C — SD (15 oz/A + 15 oz/A + 15 oz/A)
9. C — IFT (30 oz/A) (FSFR)
10. C — IFT (15 oz/A) (FSFR)
    + C — SD (15 oz/A)
11. Control

- Planted field corn hybrid (Heartland HX 1078) on June 11, 2001at 32,000 SPA
- Treatments Descriptions:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - FSFR = Full Starter Fertilizer Rate
  - HSFR = Half Starter Fertilizer Rate
  - SD = Sidedress (450 to 500 GDDs)
- 80 acre field; 5 replicates

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Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates – 2001 (Yield Map)

Project Code: C-02
Sponsor: Naturize™ BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.

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  - SD = Sidedress (450 to 500 GDDs)
- 80 acre field; 5 replicates

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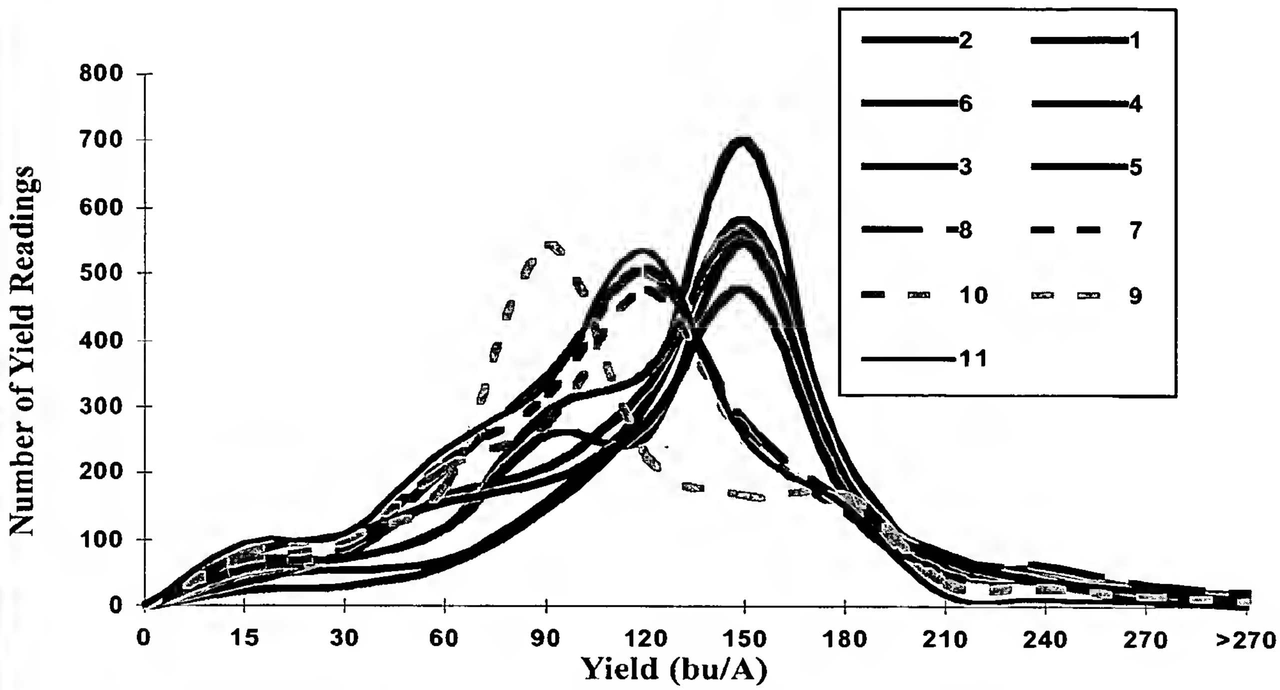
Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates – 2001 (Yield Monitor Reading Comparison)

Project Code: C-02 | Location: Hollandale, MN
Sponsor: Naturize™ BioSciences | By: Agri-Growth, Inc.



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  - B = NA2101
  - C = NA3101
  - FSFR = Full Starter Fertilizer Rate
  - HSFR = Half Starter Fertilizer Rate
  - SD = Sidedress (450 to 500 GDDs)
- Treatment Numbers:
  1. A + C — IFT (30 oz/A + 30 oz/A) (FSFR)
  2. A + C — IFT (15 oz/A + 15 oz/A) (FSFR) + A + C — SD (15 oz/A + 15 oz/A)
  3. B + C — IFT (30 oz/A + 30 oz/A) (FSFR)
  4. B + C — IFT (15 oz/A + 15 oz/A) (FSFR) + B + C — SD (15 oz/A + 15 oz/A)
  5. B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A) (HSFR)
  6. B + C — IFT (15 oz/A + 15 oz/A + 30 oz/A) (HSFR) + B + C — SD (15 oz/A + 15 oz/A)
  7. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A) (FSFR)
  8. A + B + C — IFT (15 oz/A + 15 oz/A + 15 oz/A) (FSFR) + A + B + C — SD (15 oz/A + 15 oz/A + 15 oz/A)
  9. C — IFT (30 oz/A) (FSFR)
  10. C — IFT (15 oz/A) (FSFR) + C — SD (15 oz/A)
  11. Control
- 80 acre field; 5 replicates

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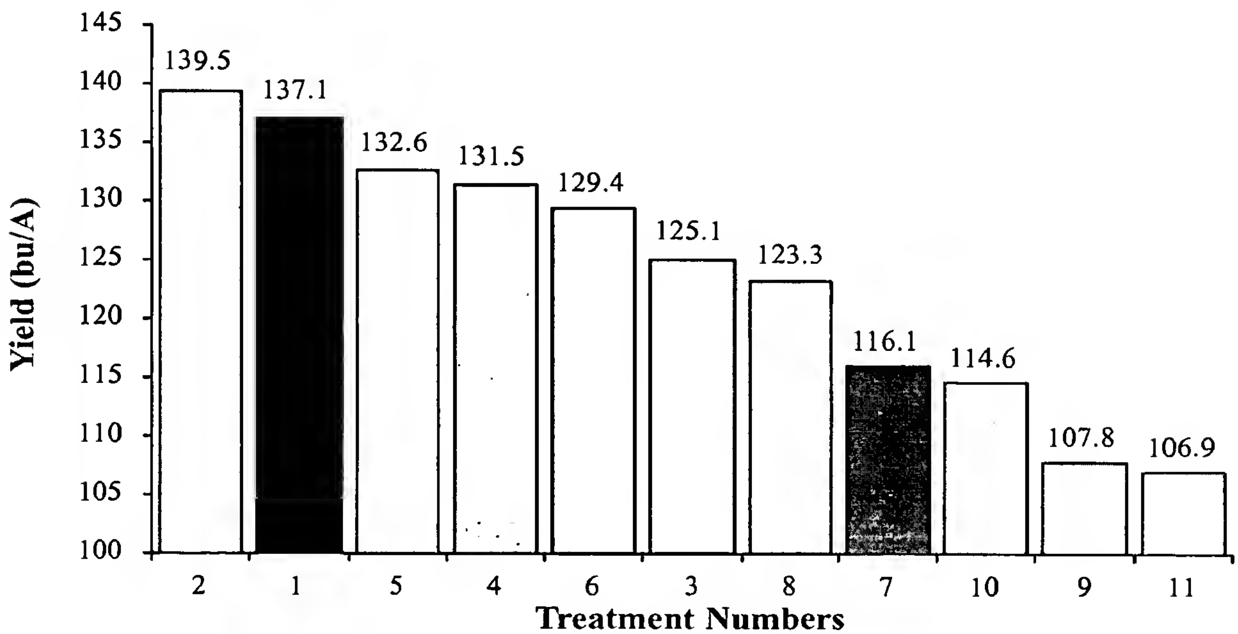
Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates – 2001 (Yield Results)

Project Code: C-02 Location: Hollandale, MN
Sponsor: Naturize™ BioSciences By: Agri-Growth, Inc.



- Planted field corn hybrid (Heartland HX 1078) on June 11, 2001at 32,000 SPA
- Treatments Descriptions:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - FSFR = Full Starter Fertilizer Rate
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  - SD = Sidedress (450 to 500 GDDs)
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  1. A + C — IFT (30 oz/A + 30 oz/A) (FSFR)
  2. A + C — IFT (15 oz/A + 15 oz/A) (FSFR) + A + C — SD (15 oz/A + 15 oz/A)
  3. B + C — IFT (30 oz/A + 30 oz/A) (FSFR)
  4. B + C — IFT (15 oz/A + 15 oz/A) (FSFR) + B + C — SD (15 oz/A + 15 oz/A)
  5. B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A) (HSFR)
  6. B + C — IFT (15 oz/A + 15 oz/A + 30 oz/A) (HSFR) + B + C — SD (15 oz/A + 15 oz/A)
  7. A + B + C — IFT (30 oz/A + 30 oz/A + 30 oz/A) (FSFR)
  8. A + B + C — IFT (15 oz/A + 15 oz/A + 15 oz/A) (FSFR) + A + B + C — SD (15 oz/A + 15 oz/A + 15 oz/A)
  9. C — IFT (30 oz/A) (FSFR)
  10. C — IFT (15 oz/A) (FSFR) + C — SD (15 oz/A)
  11. Control
- 80 acre field; 5 replicates

AGRI-GROWTH ®
Communicating leading technology to a changing industry

Evaluating the Effect of Naturize™ on Field Corn Development and Yield at Full and Half Fertilizer Rates – 2001 (Yield Results)

Project Code: C-02
Sponsor: Naturize™ BioSciences

Location: Hollandale, MN
By: Agri-Growth, Inc.

Treatments	Rate	Yield bu/A
2. A + C — IFT (FSFR) + A + C — SD	15 oz/A + 15 oz/A 15 oz/A + 15 oz/A	139.5 a
1. A + C — IFT (FSFR)	30 oz/A + 30 oz/A	137.1 a
5. B + C — IFT (HSFR)	30 oz/A + 30 oz/A + 30 oz/A	132.6 b
4. B + C — IFT (FSFR) + B + C — SD	15 oz/A + 15 oz/A 15 oz/A + 15 oz/A	131.5 b
6. B + C — IFT (HSFR) + B + C — SD	15 oz/A + 15 oz/A + 30 oz/A 15 oz/A + 15 oz/A	129.4 b
3. B + C — IFT (FSFR)	30 oz/A + 30 oz/A	125.1 c
8. A + B + C — IFT (FSFR) + A + B + C — SD	15 oz/A + 15 oz/A + 15 oz/A 15 oz/A + 15 oz/A + 15 oz/A	123.3 c
7. A + B + C — IFT (FSFR)	30 oz/A + 30 oz/A + 30 oz/A	116.1 d
10. C — IFT (FSFR) + C — SD	15 oz/A 15 oz/A	114.6 d
9. C — IFT (FSFR)	30 oz/A	107.8 e
11. Control	0	106.9 e

Means followed by the same letter do not significantly differ (P = .05 Duncan's MRT)

- Planted field corn hybrid (Heartland HX 1078) on June 11, 2001at 32,000 SPA
- Treatments Descriptions:
  - A= NA1101
  - B = NA2101
  - C = NA3101
  - FSFR = Full Starter Fertilizer Rate
  - HSFR = Half Starter Fertilizer Rate
  - SD = Sidedress (450 to 500 GDDs)
- 80 acre field; 5 replicates

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We claim:

1. A plant nutrient reduction system comprising the application to plants of a microbially enhanced inorganic fertilizer composition wherein said application results in plant growth and yield comparable to the application of substantially greater amounts of a non-microbially enhanced fertilizer composition.

ABSTRACT

The present invention relates to a plant nutrient reduction system comprising the application to plants of a microbially enhanced inorganic fertilizer composition wherein said application results in plant growth and yield comparable to the application of substantially greater amounts of a non-microbially enhanced fertilizer composition.